SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE DENVER MEETING.

THE Denver Meeting of the American Association for the Advancement of Science is an important event in the history of science in America, giving as it does official recognition to the development of science in the west. The scientific men of the country have been mostly collected together on the Atlantic seaboard between Boston and Washington, and the membership of the scientific societies has been chiefly in this region. The American Association has not hitherto met further to the west than St. Louis, and at the meeting in that city, twenty-three years ago, there were only 134 members in attendance, while two years later at Boston the attendance was 997.

During its first hundred years the nation was in scientific matters somewhat in the relation of a colony to Europe. Our students went abroad for study; we depended on Europe for our journals and books, and did not contribute our share to the work of the world. During the subsequent twenty-five years great progress has been made. The opening of the Johns Hopkins University in 1876 marked and helped to create a new epoch in university education. In the same year, the American Chemical Society was organized, leading the way in the establishment of our national societies devoted to special sciences. At about the same

time our special scientific journals were first established. In the intervening period the scientific work under the Government has remarkably expanded. The membership of the American Association increased from 867 in 1876 to 2,033 in 1883.

But this period of scientific activity has been to a large measure confined to the Atlantic seaboard. Even at the present time, we find that of the 86 members of the National Academy only one lives west of Chicago, and of the 864 fellows of the American Association only about 60 live west of that city. The central and western states have been in the colonial relation to the Atlantic seaboard that it had previously held to Europe. Students have come to the eastern universities, and the scientific men for the central and western States have been drawn from the east. But the establishment of Chicago and Stanford Universities and the development of the State universities represent the same movement that occurred earlier in the east. Within a few years the center of population — slowly moving westward and now in southern Indiana — may be the center of scientific men and scientific activity. Omens and coincidences may not appeal to men of science, but it is perhaps worth noting that the fiftieth meeting of the Association in the first year of the new century should celebrate an epoch in the development of science in America.

A little while since (June 21) there was published in this journal an article calling attention to the importance of the American Association for science in America, and it is not necessary to repeat now what was then said. We wish, however, to emphasize the significance of the approaching meeting and to urge the need of a large attendance and of a representative scientific program. The responsibility here rests with each member individually. It is not easy to say anything except the trite on such a subject, for we all know that scientific work, like everything else, depends on the willingness of all to unite for a common cause. The trip to Denver, either from the east or from the scientific centers of the west, is certainly long and expensive. When, however, the National Educational Association met recently in that city there was an attendance of 10,000 members, the largest in its history. The members of the American Association should at least aim at making the same record.

The permanent secretary informs us that many prominent scientific men from the east have signified their intention to be present, and that the representatives of science in the central and western states guarantee a large attendance. It cannot be expected that as many affiliated societies will meet at Denver as last year at New York, but the names of nine will be found on the preliminary program. We published last week a list of forty-five papers offered in chemistry, and other sciences are correspondingly well represented. The address of the President, Professor Woodward, of Columbia University, entitled 'The Progress of Science,' is certain to be an event of more than ordinary importance; and one of our most eminent students of the physical sciences will be succeeded in the chair by one of our most eminent students of the

biological sciences, Professor Minot, of Harvard University. The Association is promised a welcome by the Governor of the State, the Mayor of Denver and other dignitaries, and the people of the city are noted for their hospitality.

A few words in regard to routes may be of service to members in the East. The way to Denver is either by Chicago or St. Louis, the former being the quicker. Chicago may be reached from New York in about twenty-four hours by the Pennsylvania and New York Central Railways. For example, a train leaving New York at 7:55 A. M. by the Pennsylvania reaches Chicago at 7:45 the next morning, or a train leaving New York at 5:30 P. M. by the New York Central and Lake Shore reaches Chicago at 4:30 the next afternoon. The best train from Chicago leaves at 10 A. M. by the Chicago and Northwestern; at 1 P. M. by the Rock Island Route and 4 P. M. by the Burlington, reaching Denver at 1:40, 4:45 and 6:30, respectively, the next afternoon. Those who leave Chicago on Saturday, the twenty-fourth, by one of these trains will doubtless travel in good company. The rate from New York to Denver and return at one and one-third fare would be about $65; the ordinary fare to Chicago and return is $40, and the return ticket from Chicago to Denver is $31.50. The latter method is not much dearer than the former and may be cheaper to members living west of New York. It is more convenient, as the tickets from Chicago may be purchased as early as August 10 and are good for return until October 31, and the route to Chicago may be varied and a stop may be made at Buffalo or elsewhere. The headquarters of the Association are at the Brown Palace Hotel, and those wanting rooms should engage them in advance. There are, however, a number of good hotels at Denver.

Everyone knows that Denver is one of the great centers for excursions of scientific and general interest. The geologists, under the leadership of Professor Van Hise, have planned a ten days' excursion before the meeting. Other excursions of interest to chemists, engineers, geologists, zoologists, botanists, anthropologists and indeed to all members of the Association may be made during the meeting or at its close. It is sufficient to mention Pike's Peak, the Garden of the Gods, and the Grand Canyon of the Colorado, to all of which excursions have been planned. The trip to Colorado should be made by everyone and should be made now by all members of the American Association for the Advancement of Science.

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*REGENERATION AND LIABILITY TO INJURY.**

THERE is a widespread belief amongst zoologists that a definite relation exists between the liability of an animal to injury and its power of regeneration. It is also supposed that those individual parts of an animal that are more exposed to accidental injury, or to the attacks of enemies, are the parts in which regeneration is best developed, and conversely, that those parts of the body that are rarely or never injured do not possess the power of regeneration.

Not only do we find this belief implied in many ways, but we find this point of view definitely taken by several eminent

* One of a course of lectures on 'Regeneration' delivered at Columbia University, and shortly to be published in the Columbia University *Biological Series*.

writers, and in some cases carried so far that the process of regeneration itself is supposed to be accounted for by the liability of the parts to injury. In order that it may not appear that I have exaggerated the widespread occurrence of this belief a few examples may be cited.

Réaumur in 1742 pointed out that regeneration is especially characteristic of those animals whose body is liable to be broken, or, as in the earthworm, subject to the attacks of enemies. Bonnet (1745) thought that such a connection exists as has been already stated, and that the animals that possess the power of regeneration have been endowed with germs set aside for this very purpose. He further believed that there would be in each animal that regenerates as many of these germs as the number of times that it is liable to be injured during its natural life. Darwin in his book on 'Animals and Plants under Domestication' says: "In the case of those animals that may be bisected, or chopped into pieces, and of which every fragment will reproduce the whole, the power of re-growth must be diffused throughout the whole body. Nevertheless, there seems to be much truth in the view maintained by Professor Lessona * that this capacity is generally a localized and special one serving to replace parts which are eminently liable to be lost in each particular animal. The most striking case in favor of this view is that the terrestrial salamander, according to Lessona, can not reproduce lost parts, whilst another species of the same genus, the aquatic salamander, has extraordinary powers of regrowth, as we have just seen; and this animal is eminently liable to have its limbs, tail, eyes and jaws bitten off by other tritons."

Lang, referring to the brittleness of the tails of lizards, points out that this is a very useful character, since the bird of prey that has struck at a lizard gets hold of only the last part of the animal to disappear under cover; the lizard escapes by breaking off its tail. The brittleness of the tail is, therefore, an adaptive character that has become fixed by long inheritance.

To this example may be added that of certain land snails of the Philippine Islands. The individuals of the genus helicarion live on trees in damp forests, often in great droves. They are very active, and creep with unusual swiftness over the stems and leaves of the trees. Semper has recorded that all the species observed by him have the remarkable power of breaking off the tail (foot) close behind the shell, if the tail is roughly grasped. A convulsive movement is made until the tail comes off, and the snail drops to the ground, where it is concealed by the leaves. Semper adds that in this way the snails often escaped from him, and from his collectors, leaving nothing behind but their tails. The tail is said to be the most obvious part of the animal, and it is assumed that this is, therefore, the part that a reptile or bird would first attack.* Lang states that in this case external influences have produced an extraordinarily well developed sensitiveness in the animal, so that it reacts to the external stimulus by voluntarily throwing off the tail. It would be, of course, of small advantage to be able to throw off the tail un-

* Delage and Giard give Lessona (1869) the credit for first stating that the phenomenon of regeneration is an adaptation to liability to injury; but Réaumur first suggested this idea in 1742 and Bonnet in 1745. Delage's interpretation, viz., that Lessona ascribed this to a '*prévoyance de la nature*' has been denied by Lessona's biographer, Camerano ('La Vita di M. Lessona' *Acad. R. d. Torino* (2), XLV., 1896) and by Giard ('Sur L'autotomie Parasitaire,' etc., *Compt. Rendus de Séances de la Société de Biologie*, May, 1897).

* Whether, having once failed in this way to obtain the snail, the bird or lizard would not learn to make a frontal attack is not stated. Or shall we assume the tail is all that is wanted?

less the power of regenerating the lost organ existed, or was acquired at the same time as the extreme sensitiveness that brings about the reaction. Lang does not state, however, explicitly that he believes the regenerative power to have arisen through the exposure of the tail of the lizard and the tail of the snail to injury, although he thinks that the mechanism by means of which these parts are thrown off has been acquired in this way. Several other writers have, however, used these same cases to illustrate the supposed principle of liability to injury and power of regeneration.

Weismann in his book on 'The Germ Plasm' has adopted the principle of a connection between regeneration and liability to injury and has carried it much further than have other writers. We can, therefore, most profitably make a careful examination of Weismann's position. His general idea may be gathered from the following quotation:* "The dissimilarity, moreover, as regards the power of regeneration *in various members of the same species*, also indicates that adaptation is an important factor in the process. In proteus which in other respects possesses so slight a capacity for regeneration, the gills grow again rapidly when they have been cut off. In lizards again this power is confined to the tail, and the limbs cannot become restored. In these animals, however, the tail is obviously far more likely to become mutilated than are the limbs, which, as a matter of fact, are seldom lost, although individuals with stumps of legs are occasionally met with. The physiological importance of the tail of a lizard consists in the fact that it preserves the animal from total destruction, for pursuers will generally aim at the long trailing tail,† and thus the animal often escapes, as the tail breaks off when it is firmly seized. It is, in fact, as Leydig was the first to point out, specially adapted for breaking off, the bodies of the caudal vertebræ from the seventh onward being provided with a special plane of fracture so that they easily break into two transversely. Now if this capability of fracture is provided for by a special arrangement and modification of the parts of the tail, we shall not be making too daring an inference if we regard the regenerative power of the tail as *a special adaptation, produced by selection, of this particular part of the body, the frequent loss of which is in a certain measure provided for*, and not as the outcome of an unknown 'regenerative power' possessed by the entire animal. This arrangement would not have been provided if the part had been of no, or only of slight, physiological importance, as is the case in snakes and chelonians, although these animals are as highly organized as lizards. The reason that the limbs of lizards are not replaced is, I believe, due to the fact that these animals are seldom seized by the leg, owing to their extremely rapid movements." Overlooking the numerous cases of the regeneration of internal organs that have been known for several years, and basing his conclusion on a small, unconvincing experiment of his own on the lungs of a few salamanders, Weismann concludes: "Hence there is no such thing as a general power of regeneration; in each kind of animal this power is graduated according to the need of regeneration in the part under consideration; that is to say, the degree in which it is present is mainly in proportion to the liability of the part to injury."

After arriving at this conclusion the following admission is a decided anticlimax: "The question, however, arises as to whether the capacity of each part for regeneration results from special process of adaptation, or whether regeneration occurs

* 'The Germ-Plasm.' Translation by W. Newton Parker, 1893, page 116.

† There are no facts that show that this statement is not entirely imaginary. T. H. M.

as the mere outcome—which is to some extent unforeseen—of the physical nature of an animal. Some statements which have been made on this subject seem hardly to admit of any but the latter explanation." After showing that some newts confined in aquaria attacked each other, "and several times one of them siezed another by the lower jaw, and tugged and bit at it so violently that *it would have been torn off if I had not separated the animals,*" * and after referring to the regeneration of the stork's beak, Weismann concludes: "Such cases, the accuracy of which can scarcely be doubted, indicate that the capacity for regeneration does not depend only on the special adaptation of a particular organ, but that a general power also exists which belongs to the whole organism, and to a certain extent affects many and perhaps even all parts. By virtue of this power, moreover, simple organs can be replaced when they are not specially adapted for regeneration." The perplexity of the reader, as a result of this temporary vacillation on Weismann's part, is hardly set straight by the general conclusion that follows on the same page: "We are, therefore, led to infer that the general capacity of all parts for regeneration may have been acquired by selection in the lower and simpler forms, and that it gradually decreased in the course of phylogeny in correspondence with the increase in complexity of organization; but that it may, on the other hand, be increased by special selective processes in each stage of its degeneration, in the case of certain parts which are physiologically important and are at the same time frequently exposed to loss."

There are certain statements of facts in this chapter that are incorrect, and the argument is so loose and vague that it is difficult to tell just what is really meant. As a misstatement of fact I may select the following case. It is stated that lumbriculus does not have the power of regenerating laterally if cut in two, and it is argued that a small animal of this form could rarely be injured at the side without cutting the animal completely in two. As a matter of fact, lumbriculus can regenerate laterally, and very perfectly, as any one can verify if he takes the trouble to perform the experiment; but, of course, if the whole animal is split in two lengthwise the pieces die, or if a very long piece is split from one side the remaining piece usually disintegrates. If, however, the anterior end is split in two for a short distance, or if a piece is partially split in two, the half remaining in contact with the rest of the piece completes itself laterally. The same result follows also in the earthworm.

As an example of looseness of expression I may quote the following from Weismann: "A useless or almost useless rudimentary part may often be injured or torn off *without causing processes of selection to occur which would produce in it a capacity for regeneration.* The tail of a lizard again, which is very liable to injury, becomes regenerated because as we have seen it is of great importance to the individual and if lost its owner is placed at a disadvantage." And as an example of vagueness, the following statement commends itself: "Finally the complexity of the individual parts constitutes the third factor which is concerned in regulating the regenerative power of the part in question; for the more complex the structure is, the longer and the more energetically the process of selection must act in order to provide the mechanism of regeneration, which consists in the equipment of a large number of different kinds of cells with the supplementary determinants which are accurately graduated and regulated as regards their power of multiplication."

Without attempting to disentangle the ideas that are involved in these sentences,

* The *italics* are, of course, my own. T. H. M.

let us rather attempt to get at a general idea of Weismann's views. In a later paper (1900), in reply to certain criticisms, he has stated his position somewhat more lucidly. In the following statement I have tried to give the essential part of his hypotheses: Weismann believes the process of regeneration to be regulated by 'natural selection'; in fact, he states that it has arisen through such a process in the lower animals—since they are more subject to injury—and that it has been lost in the higher forms except where, on account of injury, it has been retained in certain parts. Thus when Weismann speaks of regeneration as being an adaptation of the organism to its environment, we must understand him to mean that this adaptation is the result of the action of natural selection. We should be on our guard not to be misled by the statement that because regeneration is useful to the animal, it has been acquired by natural selection, since it is possible that regeneration might be more or less useful without in any way involving the idea that natural selection is the originator of this or of any other adaptation. It will be seen, therefore, that in order to meet Weismann on his own ground it will be necessary to have a clear understanding in regard to the relation of regeneration to Darwin's principle of natural selection. With Weismann's special hypothesis of the 'mechanism,' so-called, by which regeneration is made possible we have here nothing to do, but may consider it on its own merits in another chapter.

In order to have before us the material for a discussion of the possible influence of natural selection on regeneration, let us first examine the facts that bear on the question of the liability of the parts to injury and their power to regenerate, and in this connection the questions concerning the renewal of parts that are thrown off by the animals themselves in response to an external stimulus are worthy of careful consideration. A comparison between the regeneration of these parts with that of other parts of the same animal gives also important data. Furthermore, a comparison may be made between different parts of the same animal, or between the same parts of different animals living under similar or under dissimilar conditions.

There are only a few cases known in which a systematic examination has been carried out of the power of regeneration of the different parts of the body of the same animal. Spallanzani's results show that those salamanders that can regenerate their forelegs can regenerate their hind legs also. Towle, who has examined in my laboratory the regeneration of a number of American newts and salamanders, finds also that both the fore and hind legs regenerate in the same forms. The tail and the gills, in those newts with external gills, also regenerate. It has also been shown in triton that the eye regenerates if a portion of the bulb is left. Broussonet first showed (1786) that the fins of fish have the power to regenerate, although, strangely enough, Fraisse and Weismann state that very little power of regeneration is present in the fins of fish. I have found that the fins of several kinds of fish regenerate, belonging to widely different families.* In *Fundulus heteroclitus* I have found that the pectoral, pelvic, caudal, anal, and dorsal fins have the power of regeneration. In reptiles the feet do not regenerate, at least no cases are known, but the tail of lizards has this power well developed. In birds neither the wings nor the feet regenerate, but Fraisse has recorded the case of a stork in which, the lower jaw being broken off, and the upper being cut off at the same level, both regenerated. Bordage has recorded the re-

* Fundulus heteroclitus, Stenopus chrysops, Decapterus macrella, Menticirrhus macrella, Carassius auratus, Phoxinus funduloides, Noturus sp., and a few others.

generation of the beak of the domesticated fighting cocks (of the Malay breed) of Mauritius. In the mammals neither the legs nor the tail, nor the jaws regenerate, although several of the internal organs, as described in the next chapter, have extensive powers of regeneration.

The best opportunity to examine the regenerative power in similar organs of the same animal is found in forms like the crustacea, myriapods and insects in which external appendages are repeated in each or many segments of the body. In decapod crustacea, including shrimps, lobsters, crayfish, crabs, hermit-crabs, etc., regeneration takes place in the walking legs of all the forms that have been examined, and this includes members of many genera and families. I have made a special examination of the regeneration of the appendages of the hermit-crab. In this animal, which lives in an appropriated snail's shell, only the anterior part of the body projects from the shell. The part that protrudes is covered by a hard cuticle, while the part of the body covered by the shell is quite soft. Three pairs of legs are protruded from the shell. The first pair with large claws are used for procuring food, and as organs of offense and defense; the second and third pairs are used for walking. The following two pairs that correspond to the last two pairs of walking legs of crabs and crayfishes, are small, and are used by the animal in bracing itself against the shell. The first three pairs of legs have an arrangement at the base, the 'breaking-joint,' by means of which the leg is thrown off, if injured. The last two pairs of thoracic legs can not be thrown off. The first three pairs of legs are often lost under natural conditions. In an examination of 188 individuals I found that 21 (or 11 per cent.) had lost one or more legs. If one of the first three legs is injured, except in the outer segment, it is thrown off at the breaking-joint, and a new leg regenerates from the broken-off end of the stump that is left. The new leg does not become full size, and is of little use until the crab has moulted at least once. The leg breaks off so close to the body, and the part inside of the breaking-joint is so well protected by the bases of the other legs, that it is scarcely possible that the leg could be torn off inside of the breaking-joint, and, as a matter of observation, all crabs that are found regenerating these legs under natural conditions do so from the breaking-joint. If, however, by means of small scissors, the leg is cut off quite near the body, a new leg regenerates from the cut end, even when the leg is cut off at its very base. The breaking-joint would thoroughly protect from injury the part of the leg that lies nearer to the body, and yet from this inner part a new leg is regenerated. Moreover, the new leg is perfect in every respect, even to the formation of a new breaking-joint. In this case we have a demonstration that there need be no connection between the liability of a part to injury and its power of regeneration.

In still another way the same thing may be shown. If the crab is anesthetized, and a leg cut off outside of the breaking-joint it is not, at the time, thrown off—the nervous system, through whose action the breaking off takes place, being temporarily thrown out of order. After recovery, although the leg is thrown off in a large number of cases, it is sometimes retained. In such cases it is found that from the cut end the missing part is regenerated. In this case also we find that regeneration takes place from a part of the leg that can never regenerate under natural circumstances.

The third and fourth legs of the hermit-crab can not be thrown off, but they have the power of regeneration at any level at which they may be cut off. They are in a

position where they can seldom be injured, and I have never found them absent or injured in crabs caught in their natural environment. The soft abdomen is protected by the snail's shell. At the end of the abdomen the last pair of abdominal appendages serve as anchors to hold the crab in the shell. These appendages are large and very hard, and can seldom be injured unless the abdomen itself is broken, and under these circumstances the crab dies. Yet if these appendages are cut off they regenerate perfectly, and after a single moult can not be distinguished from normal ones.

The more anterior abdominal appendages are present only on one side of the adult, although they are present on both sides of the larva, and to judge from a comparison with other crustacea these appendages have degenerated completely on one side, and have become rudimentary in the male, even on the side on which they are present. These appendages regenerate if they are cut off. In the female the appendages are used to carry the eggs, and are, therefore, of use. They also have a similar power of regeneration. The maxillæ and maxillipeds of the hermit-crab have also the power of regeneration, as have also the two pairs of antennæ, and the eyes.

In other decapod crustacea also it has been shown that the power of regeneration of the appendages is well developed. It has been long known that the crayfish and the lobster can regenerate lost parts. The first pair of legs, or chelæ, in these forms has a breaking-joint, at which the leg can be thrown off, yet in the crayfish I have seen that if the leg is cut off inside of the breaking-joint it will regenerate. The four pairs of walking legs do not possess a breaking-joint, but may be thrown off in some cases at a corresponding level. They regenerate from this level, as well as nearer the body and further beyond this region. Pizibram has recently shown that, in a number of crustacea, regeneration of the appendages takes place, even when the entire leg is extirpated as completely as possible.

Newport has shown that the myriapods can regenerate their legs, and it is known that several forms have the power of breaking off their legs in a definite region at the base if the legs are injured, and I have observed in *Cermatia forceps* that this takes place even when the animal is thrown into a killing fluid. Newport (1844) has also shown that when the legs of a caterpillar are cut off new ones regenerate during the pupa stage. It has been long known* that the legs of mantis can regenerate, and Bordage, who has recently examined the question more fully, has shown that a breaking-joint is present at the base of the leg. The tarsus of the cockroach also regenerates, producing only four, instead of the five, characteristic segments.†

A number of writers have recorded the regeneration of the legs of spiders.‡ Schultz, who has recently examined more thoroughly the regeneration of the legs in some spiders, finds that the leg is renewed if cut off at any level. He removed the leg most often at the metatarsus, but also at the tibia, and generally between two joints. In some cases the leg was cut off at the coxa, at which level it is generally found to be lost under natural conditions. Wagner observed in tarantula that when the leg is removed at any other place than at the coxa the animal brings the wounded leg to its jaws, and bites it off down to the coxa. In the *Epeiridæ*, that Schultz chiefly made use of, this never happened. He observed,

* See Newport and Scudder.

† Brindley, '97.

‡ Lepelletur, *Nouveau Bulletin de la Société philomatique*, 1813, Tome III., page 254.

Heincken, *Zool. Journal*, 1829, Tome IV., page 284. (Also for insects, *ibid.*, page 294.)

Müller, *Manual de Physiol.*, Tome I., page 30.

Wagner, W., *Bull. Soc. Imp., Naturel.*, Moscow, '87.

however, even in these forms that when the leg is cut off at the coxa it regenerates better than when cut off at any other level. Schultz adds that we see here an excellent example of how regeneration is influenced by natural selection, since regeneration takes place best where the leg is most often broken off. On the other hand, the author hastens to add that since regeneration also takes place when the leg is cut off at any other level this shows that the power to regenerate is characteristic of all parts of the organism, and is not *only* a phenomenon of adaptation, as Weismann believes. It seems highly improbable that a spider could ever lose a leg in the middle of a segment, *i. e.*, between two joints, since the segments are hard and strong, and the joints much weaker, but nevertheless the leg has the power to regenerate also from the middle of the segment, if cut off in this region.

The formation of the new part takes place somewhat differently, according to Schultz, when the leg is amputated between two segments than when cut off at the coxa. In the latter case, there is produced from the cut end of the last segment a solid rod which, as it grows longer, bends on itself several times. Joints appear in the rod, beginning at the base. The leg is set free at the next moult. If the leg is cut off nearer the distal end a smaller rod is formed, that extends straight forward, or may be thrown into a series of folds. It lies, however, inside of the last segment, since the surface exposed by the cut is quickly covered over by a chitinous covering. The piece is set free at the next moult.

Loeb has found that if the body of the pycnogonid, *Phoxichilidium maxillare*, is cut in two there regenerates from the posterior end of the anterior half a new body-like outgrowth.

Without attempting to describe the many cases in worms and molluscs in which there is no obvious connection between the power of the part to regenerate and its liability to injury, but where it is more difficult to show that it may not exist, let us pass to an examination of the regeneration of the starfish. It has been known since the time of Réaumur that starfish have the power of regenerating new arms if the old ones are lost. It has been claimed that in certain starfishes an arm itself can produce a new starfish (Haeckel ('78), P. and R. Sarasin ('88), von Martens ('84) and Sars ('75)), but this has been denied by other observers. It has not been found to take place in several species of starfishes, but if a portion—even a small piece—of the disc is left with the arm a new disc and arms may develop (Fig. 38, F). When the arm of *Asterias vulgaris* is injured it pinches off in many cases at its base, and a new arm grows out from the short stump that remains. These same starfishes that are regenerating new arms in their natural environment have the new arms almost always arising from this breaking region.* Thus King found out of 1914 individuals of *Asterias vulgaris* collected at random, 206, or 10.7 per cent., had one or more new arms, and all these except one arose from near the disc. In other species it appears that the outer portions of the arm may be broken off without the rest of the arm being thrown off. King has found that in asterias, regeneration takes place

* The Sarasins have described several cases in *Linkia multiformis* in which an old arm has one or more new arms arising from it. In one case, copied in our Fig. 38, G, four rays arise from the end of one arm, producing the appearance of a new starfish. In fact the Sarasins interpret the result in this way, although they state that there is no madreporite on the upper surface, and they did not determine whether a mouth is formed at the convergence of the rays, because they did not wish to destroy so unique a specimen—even to find out the meaning of it. There seems to me little probability that the new structure is a starfish, but the old arm has been so injured that it has produced a number of new arms.

more rapidly from the base than at a more distal level. It may appear at first thought, that the more rapid regeneration of the arm at the place at which it is usually thrown off may be associated with its more frequent loss at this region—in other words, that the more rapid regeneration has been acquired by the region at which the arm is generally broken off. This interpretation is, however, excluded by the fact that, in general, the nearer to the base the arm is cut off, so much the more rapid is its regeneration. In other words, the more rapid regeneration of the arm at the base is only a part of a general law that holds throughout the arm. If the proposition is reversed, and it is claimed that the arm has acquired the property of breaking off at the base, because it regenerates more rapidly at that level, the following fact recorded by King is of importance, viz., that although the arm regenerates faster at the base, yet a new arm is not any sooner produced in this way, since there is more to be produced, and the new arm from the base may never catch up to one growing less rapidly from a more distal cut surface, but having a nearer goal to reach.

The results of our examination show that those forms that are liable to have certain parts of their bodies injured are able to regenerate not only these parts, but at the same time other parts of the body that are not subject to injury. The most remarkable instance of this sort is found in those animals having breaking-joints. We find in these forms that regeneration takes place both proximal and distal to this region. If the power of regeneration is connected with the liability of a part to injury, this fact is inexplicable.

If we turn now to the question as to whether regeneration takes place in those species that are subject to injury more frequently or better than in other species, we find that the data are not very complete or satisfactory for such an examination. It is not easy to tell to what extent different animals are exposed to injury. If we pass in review the main groups of the animal kingdom, we can at least gain some interesting facts in this connection.

In the Protozoa nucleated pieces have been found to regenerate in all forms that have been examined, including amœba, difflugia, thalassicolla, paramœcium, stentor, and a number of other ciliate infusoria.

In the sponges it has been found by Oscar Schmidt that pieces may produce new individuals, but how widely this occurs in the group is not known. In the cœlenterates many forms are known to regenerate, and it is not improbable that in one way or another the process occurs throughout the group. The hydroid forms, hydra, tubularia, parypha, eudendrium, antennularia, hydractinia, podocoryne, etc.; the jelly-fish, gonionemus, and certain members of the family *Thaumantidæ*, have been found to regenerate. Amongst the *Scyphozoa*, the metridium, cerianthus and the scyphistoma of aurelia regenerate and the jelly-fishes belonging to this group have a limited amount of regenerative power.

In the Platodes we find all the triclads, that have been examined, including planaria, phagocata, dendrocœlum, and the land triclad bipalium, regenerate. It has been shown that the marine triclads also regenerate, but less rapidly and extensively, while the marine polyclads have very limited power of regeneration. The regeneration of the trematodes and cestodes has not, so far as I know, been studied, neither have the nematodes been examined from this point of view.

Some of the nemerteans regenerate, others do not seem to have this power. A small fresh water form, tetrastemma, that I examined did not regenerate although some of the pieces, that were filled with eggs, remained alive for several months.

In the annelids we find a great many forms that regenerate—many marine polychæta have this power; all earthworms that have been studied regenerate; both land forms, as lumbricus, allolobophora, etc., and fresh-water forms, as lumbriculus, nais, tubifex, etc.

In the crustacea the appendages have the power to regenerate in all the forms that have been examined.

Several kinds of myriopods as well as a number of spiders are known to regenerate their legs. In the insects, however, only a few forms are known to have this power, as caterpillars, mantis and the cockroach. The large majority of insects, in the imago state, do not seem to be able to regenerate, although they have not been sufficiently examined.

In the molluscs regeneration of the head takes place under certain conditions. Spallanzani thought that if the entire head is cut off a new one regenerates. This conclusion was denied by at least eleven of his contemporaries and confirmed by about ten others. It was found later that the result depends in part on the time of year, and in part on the kind of snail. Carriere, who more recently examined the question, found that even under the most favorable conditions regeneration does not take place if the circumœsophageal nerve-commissure is completely removed with the head, but if a part remains, a new head develops. It has been stated that a new foot regenerates in helicarion, and I have found the foot regenerates also in the fresh-water snails, physa, limnœa and planorbis. If the margin of the shell of a lamellibranch or of a snail is broken off it is renewed by the mantle. The arms of some of the cephalopods are known to regenerate, particularly the hectocotylized arm.

In all the main groups of echinoderms, with one possible exception, regeneration has been found to take place. Probably all starfishes and brittle-stars regenerate their arms, and even if cut in two or more pieces new starfishes develop. The crinoids regenerate lost arms, and even parts of the disc; also the visceral mass. The holothurians have very remarkable powers of regeneration. In some forms regeneration takes place if the animals are cut in two, or even in more than two pieces. The remarkable phenomena of evisceration that take place in certain holothurians, if they are roughly handled, or kept under unfavorable conditions, are well known, and have been described by a number of writers. It has even been suggested that the holothurian may save itself by offering up its viscera to its assailant! Unfortunately for this view, it has been found that the viscera are unpalatable, at least to sea-anemones and to fishes. Ludwig and Minchin suggest that the throwing off of the cuvierian organs, that are attached to the cloaca, is a defensive act, and if carried too far, according to the latter writer, the viscera may also be lost. The holothurians have remarkable recuperative powers and may regenerate new viscera in a very short time. The sea urchins, form, perhaps, an exception in this group since there are no records of their regenerative power, but no doubt this is because they have not been as fully investigated as have other forms.

In the vertebrates we find that the lower forms, amphioxus, petromyzon and sharks, have not been studied in regard to their regenerative power. In the teleostean fishes, the fins of a number of forms have been found to regenerate. It is probable that this takes place in most members of the group.

In the amphibia we find a large number of forms that regenerate their limbs and tail, and other parts of the body, but limitations appear in certain forms. The rapid regeneration of the legs in the smaller urodeles has been often described. In larger

forms it takes place more slowly, at least in large forms having large legs. In proteus the regeneration may extend over a year and a half, and in necturus it takes more than a year to make a new limb, at least in animals in confinement. In the large form, amphiuma, that has extremely small legs regeneration takes place much more rapidly than in a form like necturus having much larger legs.

In amphiuma the feet are not used by the animal as organs of locomotion, since they are too small and weak to support the heavy body. They can be moved by the animal in the same way that the feet are moved in other forms, and yet are useless for progression. It is said by Schreiber that the regeneration of the legs of *Triton marmoratus* is relatively very slight as compared with that of other forms. Fraisse also found in this form that an amputated leg did not grow again, only a deformed stump being produced. The tail, also, is said to regenerate to only a slight extent, but, so far as I know, there is nothing peculiar in the life of this form that makes it less liable to injury than other large urodeles.* Weismann cites the case of proteus that is said also to regenerate less well than do other forms. It lives in the caves of Carniola, where there are few other animals that could attack or injure it, and to this immunity is ascribed its lack of power of regeneration, yet Goette states that he observed a regenerating leg in this form, but that the process was not complete after a year and a half. In necturus also, which is not protected in any way, regeneration is equally slow. Frogs are unable to regenerate their limbs, although they are sometimes lost, but the larval tadpole can regenerate at least its hind legs. In the reptiles the tail regenerates, though this is accomplished more readily in some groups than in others, but at present we do not know of any connection between this condition and the liability of certain forms to injury. Turtles and snakes do not regenerate their tails. I do not know of any observations on crocodiles.

In birds, the legs and wings are not supposed to have the power to regenerate,* but in two forms† at least the beak has been found to possess remarkable powers of regeneration. There are a few very dubious observations in regard to the regeneration in man of superfluous digits that had been cut off.‡

These examples might be added to by others in the groups cited, and also by examples taken from the smaller groups of the animal kingdom, but those given will suffice, I think, to show that the power to regenerate is characteristic of entire groups rather than individual species. When exceptions occur, we do not find them to be forms that are obviously protected, but the lack of regeneration can rather be accounted for by some peculiarity in the structure of the animal. If this is borne in mind as well as the fact that protected and unprotected parts of the same animal regenerate equally well, there is established, I think, a strong case in favor of the view that there is no necessary connection between regeneration and liability to injury. We may, therefore, leave this side of the question and turn our attention to another consideration.

It will be granted without argument that the power of replacement of lost parts is of use to the animal that possesses it, especially if the animal is liable to injury. Cases of usefulness of this sort are generally

*I do not know whether this animal was kept long enough to make it certain that the legs do not regenerate.

*A statement to the contrary quoted in Darwin's 'Animals and Plants under Domestication,' is doubted by Darwin himself.

†The stork and the fighting cocks.

‡See Darwin, *loc cit.*

spoken of as adaptations. The most remarkable fact in connection with these adaptive responses is that they take place, in some cases at least, in parts of the body where they can never, or at most very rarely, have taken place before, and the regeneration is as perfect as when parts liable to injury regenerate. Another important fact is that in some forms the regeneration is so slow that if the competition amongst the animals was very keen, those with missing legs, or eyes, or tails, would certainly succumb; yet if protected they do not fail to regenerate. If, therefore, the animal can exist through the long interval that must elapse before the lost part regenerates, we can not assume that the presence of the part is of vital importance to the animal and hence its power to regenerate could scarcely be described as the result of a 'battle for existence,' and without this principle 'natural selection' is powerless to bring about its supposed result.

It is extremely important to observe that some cases, at least, of regeneration are not adaptive. This is shown in the case where a new head regenerates at the posterior end of the old one in *Planaria lugubris*, or where a tail develops at the anterior end of a posterior piece of an earthworm, or when an antenna develops in place of an eye in several crustacea. If we admit that these results are due to some inner laws of the organisms, and have nothing to do with the relation of these organisms to the surroundings, may we not apply the same principle to other cases of regeneration in which the result is useful?

So firm a hold has the Darwinian idea of utilitarianism over the thoughts of those who have been trained in this school, that whenever it can be shown that a structure or a function is useful to an animal it is without further question set down as the result of the death struggle for existence. A number of writers, being satisfied that the process of regeneration is useful to the animal, have forthwith supposed that, *therefore*, it must have been acquired by natural selection. Weismann has been cited as an example, but he is by no means alone in maintaining this attitude. It would be entirely out of place to enter here into a discussion of the Darwinian theory, but it be well worth while to consider it in conmay nection with the problem of regeneration.

We might consider the problem in each species that we find capable of regenerating; or if we find this too narrow a field for our imagination we might consider the process of regeneration to have been 'acquired by selection in the lower and simpler forms' and trace its subsequent progress as it decreased in the course of phylogeny 'in correspondence with the increase in complexity of organization' or with the decrease of exposure to injury. At the risk of following the narrower point of view I shall confine the discussion to the possibility of regeneration being acquired, or even augmented, through a process of natural selection in any particular species.

The opportunity to regenerate can only occur if a part is removed by accident or otherwise. On the Darwinian theory we must suppose that of all the individuals of each generation that are injured *in exactly the same part of the body*, only those have survived or have left more offspring that have regenerated. In order for selection to take place it must be supposed that amongst these individuals injured *in exactly the same region* regeneration has been better in some forms than in others, and that this difference is, or may be, decisive in the competition of the forms with each other. The theory does not inquire into the origin of this difference between individuals, but rests on the assumption of individual differences in the power to regenerate, and assumes that

these differences can be heaped up by the survival and inbreeding of the successful individuals, *i. e.*, it is assumed that, by this picking out or selection through competition in each generation of the individuals that regenerate best, the process will become more and more perfectly carried out in the descendants until at last each part has '*acquired*' the power of complete regeneration.

There are so many assumptions in this argument, and so many possibilities that must be realized in order that the result shall follow, that, even if the assumptions were correct, one might still remain skeptical in regard to the possibilities ever becoming realized. If we examine somewhat more in detail the conditions necessary to bring about this supposed process, we shall find ample grounds for doubt, and even, I think, for denial, that the results could ever have been brought about in this way.

In the first place the assumption that the regeneration of an organ can be accounted for as a result of the selection of those individual variations that are somewhat more perfect, rests on the grounds that such variations occur, for the injury itself that acts as a stimulus is not supposed to have any direct influence on the result, *i. e.*, for better or worse. All that natural selection pretends to do is to build up the complete power of regeneration by selecting the most successful results in the right direction. In the end this really goes back to the assumption that the tissue in itself has a fuller power to regenerate completely in some individuals than in others. It is just this difference, if it could be shown to exist, that is the scientific problem. But, even leaving this criticism to one side, since it is very generally admitted, it will be clear that in many cases most of the less complete stages of regeneration that are assumed to occur in the phyletic series could be, in each case, of very little use to the individual. It is only the completed organ that can be used; hence the very basis of the argument falls to the ground. The building up of the complete regeneration by slowly acquired steps, that can not be decisive in the battle for existence is not a process that can be explained by the theory.

There is another consideration that is equally important. It is assumed that those individuals, that regenerate better than those that do not, survive, or at least have more descendants; but it should not be overlooked that the individuals that are not injured (and they will belong to both of the above classes) are in even a better position than are those that have been injured and have only incompletely regenerated. The uninjured forms, even if they did not crowd out the regenerating ones, which they should do on the hypothesis, would still intercross with them, and in so doing bring back to the average the ability of the organism to regenerate. Here we touch upon a fatal objection to the theory of natural selection that Darwin himself came to recognize in the later editions of the 'Origin of Species,' viz., that unless a considerable number of individuals in each generation show the same variation the result will be lost by the swamping effects of intercrossing. If this be granted, there is left very little for selection to do except to weed out a few unsuccessful competitors, and if the same causes that gave origin to the new variation on a large scale should continue to act, it will by itself bring about the result, and it seems hardly necessary to call in another and questionable hypothesis.

Finally, a further objection may be stated that in itself is fatal to the theory. We find the process of regeneration taking place not only at a few vulnerable points, but in a vast number of regions, and in each case regenerating only the missing part. The leg of a salamander can regenerate from every

level at which it may be cut off. The leg of a crab also regenerates at a large number of different levels, and apparently this holds for all the different appendages. If this result had been acquired through the action of natural selection, what a vast process of selection must have taken place in each species! Moreover, since the regeneration may be complete at each level and in each appendage without regard to whether one region is more liable to injury than is another, we find in the actual facts themselves nothing to suggest or support such a point of view.

If, leaving the adult organism, we examine the facts in regard to regeneration of the embryo, we find again insurmountable objections to the view that the process of regeneration can have been produced by natural selection. The development of whole embryos from each of the first two or first four blastomes can scarcely be accounted for by a process of natural selection, and this is particularly evident in those cases in which the two blastomeres can only be separated by a difficult operation and by quite artificial means. If a whole embryo can develop from an isolated blastomere, or from a part of an embryo without the process having been acquired by natural selection, why apply the latter interpretation to the completing of the adult organism?

Several writers on the subject of regeneration in connection with the process of autotomy (or the reflex throwing off of certain parts of the body) have, it seems to me, needlessly mixed up the question of the origin of this mechanism with the power of regeneration. If it should prove true that in most cases the part is thrown off at the region at which regeneration takes place to best advantage, it does not follow at all that regeneration takes place here better than elsewhere, because in this region a process of selection has most often occurred. The phenomenon of regeneration in the arm of the starfish, that has been described on a previous page shows how futile is an argument of this sort. If, on the other hand, the autotomy is supposed to have been acquired in that part of the body where regeneration takes place to best advantage, then our problem is not concerned with the process of regeneration at all, but with the origin of autotomy. If the attempt is made to explain this result also as the outcome of the process of natural selection acting on individual variations, many of the criticisms advanced in the preceding pages against the supposed action of this theory in the case of regeneration, can also readily be applied to the case of autotomy.

T. H. Morgan.

SOME CONDITIONS INFLUENCING SUCCESS AT SCHOOL.

The law of universal variation as demonstrated by the pupils of our public schools has presented a most difficult problem to the superintendent. He is 'between the devil and the deep sea' in his attempts to give the individual his rights, and at the same time conform to a system which is capable of turning out good material in large quantities. Procrustean beds, with semi-elastic foot-boards are about the best that can be provided for the little folks in the large cities, even under the best conditions. The problem is an important one and far from a satisfactory solution, but we have all confidence in the brains which are brought to bear upon it, and it cannot be very long before some one of the systems which are now in the experimental stage will show itself worthy of more extended adoption. Whatever variety there may be in the attempts to solve this problem of promotion in the schools—for after all, it resolves itself to that—there are certain facts

underlying it upon which there is a most perfect consensus of opinion. One of them is the universal variability already alluded to. In every grade known to modern school systems are found some pupils who seem to fit the conditions almost perfectly and others who are palpable misfits. They are not only misfits where they are, but have always been so wherever they have been, and will probably remain misfits to the end of the school chapter. This is not to characterize them as useless members of society, nor as vicious, but simply as odd-shaped cogs which do not quite fit the educational mechanism. Clumsy machinery might work fairly well with them, but not the carefully adjusted tools of a big public-school plant, and some modifications must be made for them. Nor are these failures to coincide all in the same degree. Some go through the whole mill with only a moderate amount of friction. Others find the wheels revolving too rapidly or too slowly. For the former, some parts must be gone through twice, for the latter, time is wasted. The greatest good for the greatest number is all that can be hoped for and in its accomplishments some few may long have to suffer for the weal of the many.

This study does not present a panacea for these difficulties. It is not remedial, but rather in the nature of a further diagnosis of the conditions. It asks the question: What physical and mental conditions in the child most often accompany success and failure in grade work? It also attempts to answer the question for the limited field covered.

The method and scope of the problem are as follows: About 2,000 copies of the blank here printed were sent out to the superintendents of schools in eight cities and towns of the State of Colorado, who had, in response to a letter previously sent out, signified their willingness to help with the problem. Colorado towns were not chosen because of any special geographical value, but for the simple reason that I was a resident of the State and acquainted with its educators. In fact, the geographical restriction perhaps limits the value of the study, rather than enhances it. With the blanks were sent out full directions for filling them out. (1) That they be given only to such teachers as the superintendent felt would do the work with care and good judgment. (2) That the teachers to whom they were intrusted fill out one blank for each pupil in the grade, putting an X in

City .....

Grade ——— Sex ——— Age ———

1. Height (for grade), Tall —; Above medium —; Below medium —; Short —
2. Weight (for grade), Heavy —; " " —; " " —; Light —
3. Health (apparent), Perfect —; " " —; " " —; Poor —
4. Native Ability—Bright —; " " —; " " —; Dull —
5. Habit—Industrious —; " " —; " " —; Lazy —
6. Temperament—Nervous —; " " —; " " —; Stolid —
7. Home Conditions—Good —; " " —; " " —; Bad —
8. Occupation of father .....

STANDING IN CLASS.

(*Based upon marks actually given.*)

9. *Grading:* 1st ¼ class —; 2d ¼ class —; 3d ¼ class —; 4th ¼ class —
10. *Deportment:* ditto —; ditto —; ditto —; ditto —

Remarks .....

.....

.....

the proper space under each question. (3) That for each question there be an equal number for every grade, included in each of the four divisions of the question—*i. e.*, in the case of the first question for a grade of 32 pupils, let 8 be put down as tall and the same number for each of the other three classifications, and the same be done as nearly as possible for all the other questions (except 8). This it may be seen demanded careful judgment and discrimination on the part of the teacher, and I cannot vouch for its accuracy, but knowing many of the teachers as I do, I believe the returns are as valid as can be expected from any work of this kind. In the directions especial attention was called to the fact that answers to 9 and 10 were not to be based upon immediate judgment, but upon that of the past as far as possible. No exact measurements were called for even in cases of 1 and 2. The values are in every case relative and in this respect differ from those of other studies of a similar nature. This method has some advantages and some disadvantages. It obviates the necessity for exact measuring apparatus which the teacher might not know how to use, although it introduces an error of individual judgment. The important thing is, however, that we have for every individual grade or room considered, the fourfold classification along nine different lines, by a tabulation of which it is possible to determine whether, right through the grades, the pupils successful with their school work were as a rule the tall or the short ones, the heavy or the light, the healthy or the sickly ones, and by a fuller analysis possibly throw more light on the relative values of other conditions of heredity and environment.

In the preparation of the accompanying curves the data for only 1,000 pupils were used, and those wholly from the grades below the 7th. This was done that with a later study a comparison might be made between the non-adolescent stage covered by this paper and the adolescent, made up of pupils of the 7th and 8th grades and possibly the first year or two of the high school.

The curves shown on the accompanying figures are all constructed upon the same general principles, and show the relation between the conditions of heredity and environment covered by the questions 1 to 9, inclusive (except 8), and success in school work covered by question 10. In other words, an attempt to show graphically the influence of the former upon the latter. Each figure shows this relation for a single one of the first nine questions. Neither specific grade nor age is considered, the grades from one to six being taken as a group. For each figure, the four columns represent the 1st, 2d, 3d and 4th quarter of the 1,000 pupils considered with respect to the condition of question 10, which has to do with their grading in school work. In every case the 1st column has to do with the pupils at the head of the class; the 4th with those at the foot; the other two, those of intermediate grading.

The curves upon the figures are for the condition covered by the other questions, and by their ordinate distances (*i. e.*, height above the base-line) show the relation between them and the grading. To explain more fully, upon each figure the heavy entire curve is for the first part of the question, tall, heavy, perfect, bright, etc., according as it is on the figure for height, weight, health, native ability, etc.; the dotted curve for the 'above medium' points of the question; the broken curve for the 'below medium'; and the light, entire curve for the remainder—the short, light, poor, dull, etc. Ordinate distances show percentages of children of each condition of heredity and environment in any of the divisions of the class with reference to the grading.

To interpret Fig. 1, which is for condition of height in terms of this description, by following the heavy curve—that for children designated 'tall'—we find that 8 per cent. (in every case omitting fractions of percentages) of such children were in the 1st quarter of the class in their grading (left-hand column), 23 per cent. in the 2d quarter (3d column), 28 per cent. in the 3d quarter (3d column), and 32 per cent. in the quarter at the foot of the class as far as scholarship goes (last column). By following in the same way the dotted, the broken and the light entire curve we can see the relation between the children adjudged to be above medium, below medium and short of stature. To generalize from the figure as a whole, its indications are that the short children, as a class, were the ones for whom promotion was most probable, while the tall children seem to stand lower in their school work according to

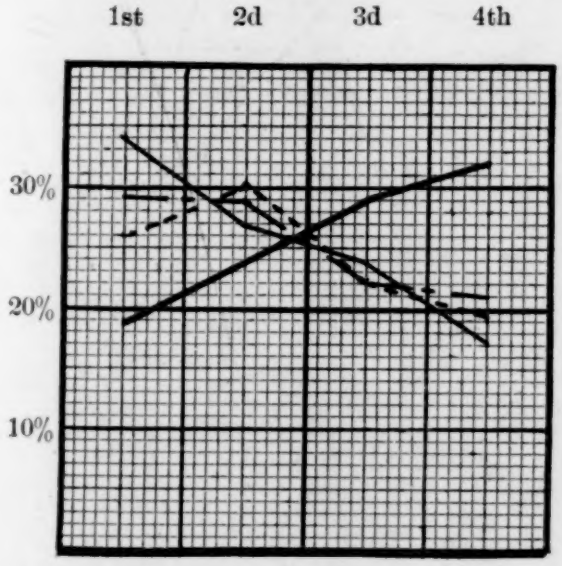

FIG. 1. Height.

the estimation of their teachers. This is not in accordance with the conclusions of some others who have studied the same problem; notably, MacDonald (see 'Ex. Study of Children,' *U. S. Com. Ed.*, 1897–8, Vol. I.), who finds a slight preponderance of height in favor of the bright pupils. A fixed relation, however, may exist between height and physical conditions, and since the latter forms the basis of study for another figure I shall allude to it under that.

WEIGHT.

The curves upon Fig. 2, and the succeeding ones are to be determined exactly as the preceding. We find from an inspection of Fig. 2 that the heavy children gravitate toward the foot of the class, though not to a very marked degree. From the study of the separate sexes I find this to be more marked for the boys than the girls, though showing slightly for the latter. In the re-

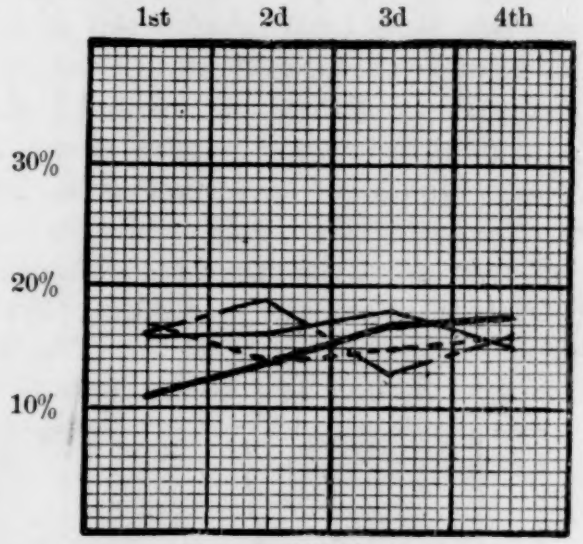

FIG. 2. Weight.

lation between weight and success in school work shown here we are also opposed by the authority just cited, as MacDonald states that in height, sitting height, weight and cranial circumference the bright boy excels the dull. This contradiction may be due to geographical differences. Something more than three-fourths of the children included in my study were residents of the mountain towns of an altitude of nearly two miles, and none were much lower than one mile. If the differences be due to this fact they are in accord with general anthropological studies made upon adults.

HEALTH.

We find upon Fig. 3 a very probable corroboration of the old dictum *mens sana in*

corpore sano. The seeming influence of good health upon good standing is certainly very marked, and the symmetry of the two curves for good and poor health is very striking. The study of the two sexes separately seems to throw some interesting side lights. For the boys and girls in perfect health about the same conditions are indicated as for the two groups, but for poor health it would seem that the direction is given the curve mainly by the boys. The percentages of girls of poor health in the 1st and 4th quarters of the class as to scholarship were the same (26 per cent.), while less than 1 per cent. of the boys in poor health were at the head of the class to 40 per cent. of them at the foot. This would seem to imply that even before the adolescent stage of development the girls have the power of forcing themselves to do work even when vitality is low, which has generally been attributed to them only at a later stage. If so, it is a fact which deserves more attention from the teacher, for it can only be accomplished at the expense of energy which is demanded by other activities. Pride and over-sensitiveness are responsible for many evils and probably are in evidence here.

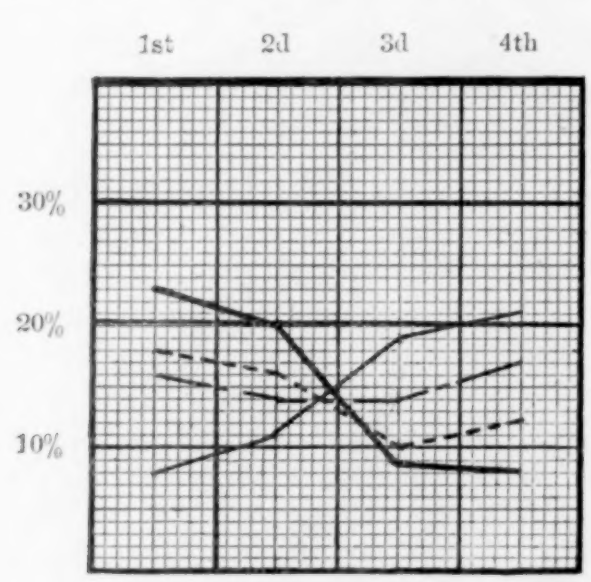

FIG. 3. Health.

NATIVE ABILITY AND HABIT.

Conclusions based upon the answers to their questions have perhaps less value than any of the others, because of the difficulty the teacher must have in disassociating the conditions from those of scholarship

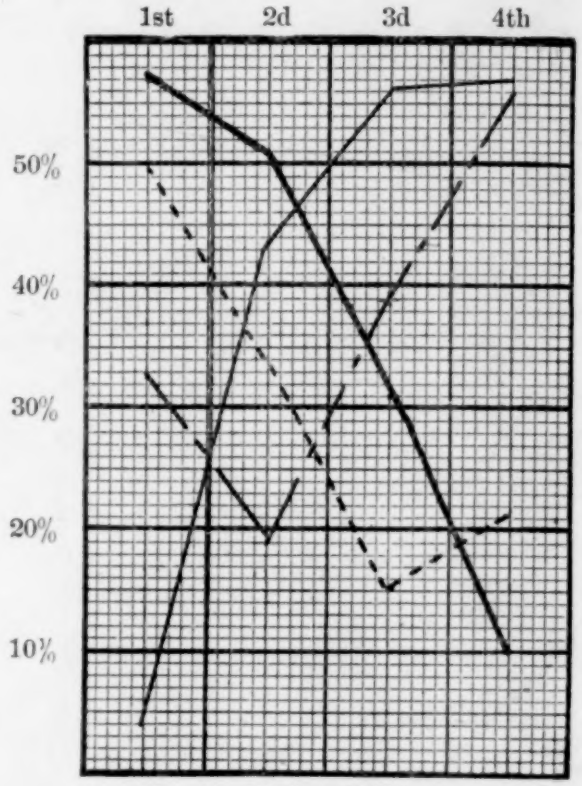

FIG. 4. Native Ability.

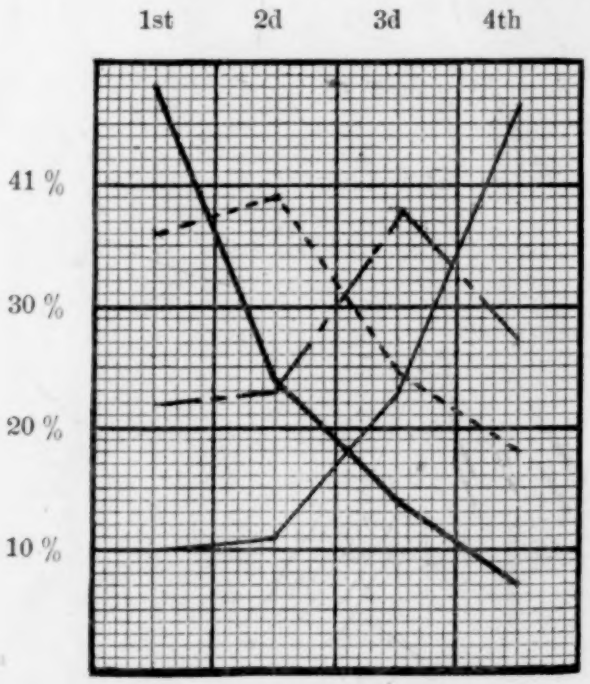

FIG. 5. Habit.

with which they are to be compared. When the teacher was answering them for a given pupil she could hardly fail to have in mind his class standing and be influenced by it; one can hardly tell how much influence this might have upon the results. We should expect, however, on other grounds to find the bright and industrious pupils in the 1st quarter of the class as to grading, and *vice versa*, and the curves show them to be there. Based upon the teachers' judgment, there seems to be little difference in the influence for the two sexes. In each case about half of the bright and industrious pupils were at the head of the class, while the other half were unequally distributed through the other three divisions, with very few at the foot.

TEMPERAMENT.

Fig. 6 shows that the children whom the teacher characterized as 'nervous' preponderated in the upper half of the class, considered from the standpoint of work. No directions were given as to classification under this head, and we cannot say that all had the same conception as to its meaning. The term may be made to cover a multitude of different manifestations, but it is perhaps safe to conclude that for the most

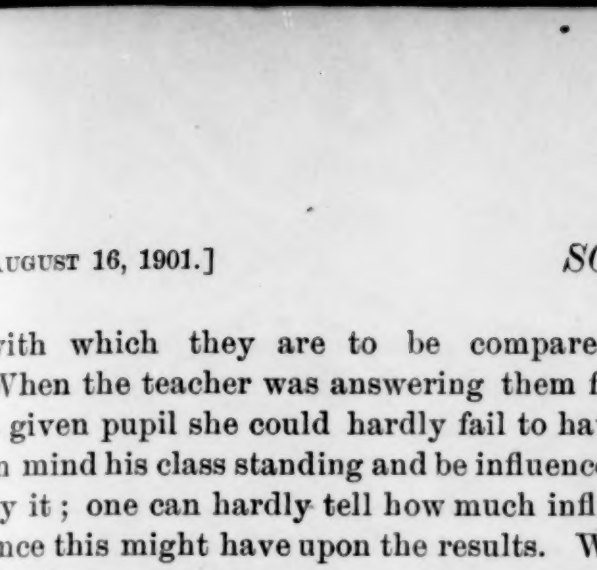

FIG. 6. Temperament.

it meant an excess of energy worked off through motor channels other than those of the legitimate business of the school. It will be noticed that the greatest percentage of 'nervous' children were in the 2d quarter of the class, with the first showing them next in abundance. This would seem to imply that an abundance of nervous energy is essential to good work but somewhat detrimental to the best of work. It has perhaps been noticed that in our treatment of the whole problem we have been forced to study each condition as if the others were not at the same time active. That is, in isolating the matter of temperament for the curves under discussion, we have disregarded native ability, habit, health and all the rest between which and temperament there may exist a fixed relation. In fact, it would be quite reasonable to suppose that such a relation did exist between some of them, and perhaps the most probable would be that between temperament and health. It was proved that children of poor health were seldom found at the head of the class. But children of poor health are not infrequently excessively nervous. Putting these two facts together, the failure to find the greatest number of nervous children in the 1st quarter of the class seems quite reasonable. For the other extreme of nervousness, which I have characterized as 'stolid,' there is a gradual increase in number from the head to the foot of the class. With the girls there seemed to be the greatest difficulty in overcoming the seeming impediment of stolidity, there being but a fraction over 1 per cent. of those so characterized in the 1st quarter of the class. Perhaps they lacked to an extreme the elements of pride, which is such an instigation to work.

HOME CONDITIONS.

The directions for answering this question stated that home conditions which

were to be considered as good were those which were considered as conducive to study and regular attendance at school, while bad home conditions were those that made this improbable. The latter might be due either to the general attitude of the parents toward school work in general, or the economic condition which left little time for study or caused frequent absences. The curves upon Fig. 7 are about what might with reason be expected, showing but a small chance for good scholarship under the latter condition. The study of the two sexes separately showed that the home influences had a wonderfully more tenacious grip upon the girls than upon the boys; less than 1 per cent. of the former whose home conditions were designated as poor, could force themselves into the 1st quarter of the class, while 20 per cent. of the boys managed to pull themselves out of the mire to that standing. Washing dishes

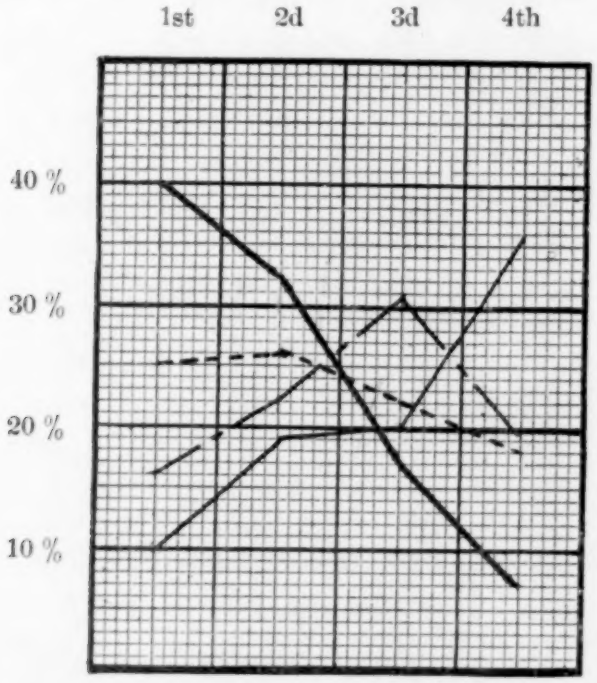

Fig. 7. Home Condition.

and doing other home duties may have had something to do with the difficulties of the girls—duties from which the boys frequently escape—but I am inclined to think that the difference is largely due to the more dominating influence upon the girl of the attitude of the home toward educational matters. She can hardly escape from it. She carries it to school with her, and if it be poor it drags her down. With the boy it is different. A game of ball or of marbles before school puts him into another world, and he does not reenter the depressing one of home until he is forced to, and even then he makes an early escape.

DEPORTMENT.

I do not consider the curves upon Fig. 8 of much value. They show a very marked relation between good deportment and good

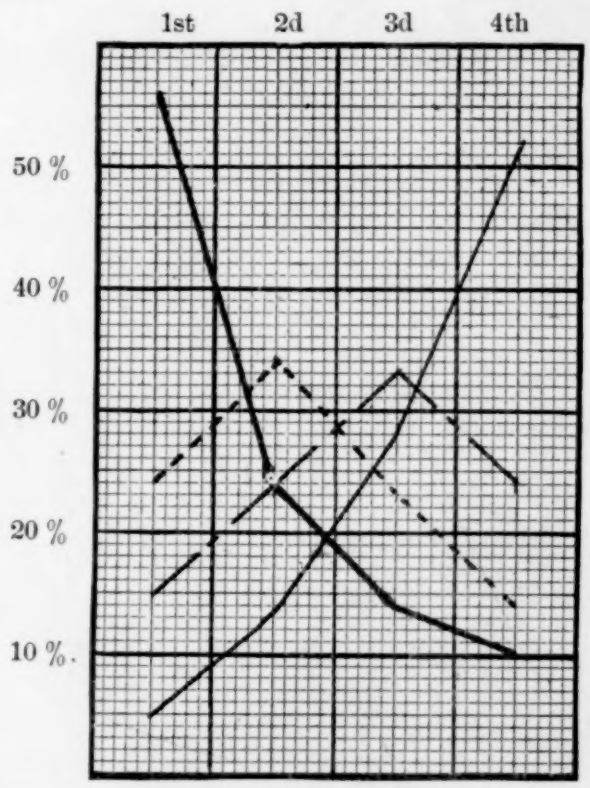

Fig. 8. Deportment.

class standing, but it takes a very hard-hearted teacher to give the best pupil in the grade, or those who are pushing him closely for honors, a mark for bad deportment, and I know the good teachers of Colorado too well to believe that they could easily do it. His marks, by a kind of mental osmosis intermingle, and with all respect for the good intentions of the teacher, I put this in more as a study of them and an apostrophe to

their good nature than as having any great scientific value from the standpoint of our problem.

EDWIN G. DEXTER.
UNIVERSITY OF ILLINOIS.

MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE following have completed their membership in the American Association for the Advancement of Science during the month of July:

Frank Anderson, Mining Engineer, 255 East 2nd St., Salt Lake City, Utah.

William S. Andrews, Electrical Engineer, care of General Electric Co., Schenectady, N. Y.

Marshall H. Bailey, M.D., 47 Brattle St., Cambridge, Mass.

Professor Solon I. Bailey, Associate Professor of Astronomy, Harvard College Observatory, Cambridge, Mass.

Wm. C. Banks, Electrician, Gordon Battery Co., New York, N. Y.

Philip P. Barton, Superintendent Niagara Falls Power Co., 127 Buffalo Ave., Niagara Falls, N. Y.

James P. Baxter, President Maine Historical Society, Portland, Me.

Josiah H. Benton, Jr., Lawyer, Ames Building, Boston, Mass.

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Joseph E. Blackburn, State Dairy and Food Commissioner, Box 231, Columbus, O.

Miss Charlotte Bowditch, Pond St., Jamaica Plain, Mass.

Edward C. Briggs, Professor of Dental Materia Medica and Therapeutics, Harvard Medical School, Boston, Mass.

Paul T. Brodie, Professor of Mathematics, Clemson College, S. C.

Rev. Earle A. Brooks, 161 Laidley St., Charleston, W. Va.

Joseph S. Brown, 241 South 5th St., Reading, Pa.

Luther Burbank, Horticulturist, Santa Rosa, Cal.

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Charles W. Frederick, Computer, United States Naval Observatory, Washington, D. C.

Augustus H. Fretz, Doylestown, Pa.

Arthur L. Fuller, Brunner, Texas.

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Christian B. Hoffman, Enterprise, Kan.

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George P. Singer, Professor of Physics, Central State Normal School, Lock Haven, Pa.

Dr. Robert L. Slagle, President State School of Mines, Rapid City, S. D.

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SCIENTIFIC BOOKS.

RECENT BOOKS ON PHYSICS.

Natural Philosophy for General Readers and Young People. Translated from Ganot's 'Cours élémentaire de physique,' by E. ATKINSON. Ninth edition, revised by A. W. REINHOLD. Longmans, Green & Co. 1900. Pp. 752.

Elements of Physics. By C. HANFORD HENDERSON and JOHN F. WOODHULL. D. Appleton & Co. 1900. Pp. 388.

A Brief Course in General Physics. By GEORGE A. HOADLEY. American Book Company. 1900. Pp. 463.

One Thousand Problems in Physics. By WILLIAM H. SNYDER and IRVING O. PALMER. Ginn & Co. 1900. Pp. 142.

A Manual of Laboratory Physics. By H. M. TORY and F. H. PITCHER. John Wiley & Sons. 1901. Pp. 288.

Advanced Exercises in Practical Physics. By ARTHUR SCHUSTER and CHARLES H. LEES. England, Cambridge University Press; New York, The Macmillan Company. 1901. Pp. 368.

It was in 1863 that Dr. Atkinson first put before English readers his excellent translation of Ganot's 'Éléments de Physique,' a book which quickly won favor by its good arrangement and lucidity. In the first edition he graciously apologized for the use of the metric system. It has passed through fifteen or more editions since its introduction. A demand soon arose for the more elementary course by the same French author, as a text-book for the middle and upper classes of schools preparatory to college. The popularity of this is manifested by the appearance now of its ninth edition, a considerable part of which had been prepared for the press before the death of Dr. Atkinson. The present volume has all the excellences of its predecessors, the illustrations being abundant, and some of them possibly a trifle too expensive. Colored lithographs of metallic spectra and of Geissler tube discharges were formerly fashionable, but in a general treatise to-day they seem almost out of date. For the general reader it would be hard to find a more pleasant and satisfactory book than this volume. For American school purposes, however, it is too diffuse; and it seems adapted only for recitational purposes where oral answers are given to questions relating to descriptive details and general principles. Physics is nothing if not a quantitative science. This idea is best instilled into the elementary student, even though his mathematical attainments be not sufficient to warrant the use of complex problems.

The present volume illustrates the difficulty of maintaining a text-book up to date by slight modifications and additions applied in succession to a long series of new editions. As years pass on, the necessity for omissions becomes as

important as for additions. On page 207 a paragraph about the audiphone states that "not merely deaf people, but even those who are deaf *and dumb*, can hear musical sounds and *even speech*." The amiable admission implied in what the present writer italicizes is evidently due to the acceptance of a Chicago advertisement. On page 370, in discussing the mechanical equivalent of heat, the name of Rowland has been forgotten by the reviser. A few wood cuts might have been omitted, such as that (page 27) in which the source of the wind that propels a sail-boat is a cherub face nestled among the clouds, its cheeks distended to the bursting point.

The 'Twentieth Century Text-book,' by Henderson and Woodhull, is decidedly more modern, and is comparable with Ganot in the abundance and attractiveness of the illustrations. An appeal is made to the student's human sympathies by the introduction of portraits, with short life sketches, of men whose researches have enlarged the domain of physics, such as Newton, Franklin, Tyndall, Faraday and Lord Kelvin. To this list is added Mozart, naturally in the chapter on music. A comparison of this chapter with those on heat and electricity indicates plainly, without reference to the title page, that the book has been prepared by two men of quite different tastes and aptitudes. The introductory chapters and those on sound and music indicate a writer whose fondness for metaphysics and æsthetics is quite equal to his appreciation of physics. A prosaic student, after studying through the first chapter, is stimulated by such problems as these:

1. "Select five events and analyze them into their matter and motion content."

2. "If a monkey sit on the top of a pole, and always face a man who walks around the pole, with his face always turned toward the monkey, can the man be said to walk around the monkey?"

The mathematical solution of the second problem is easy. Teachers may differ about the metaphysical solution. In the chapter on music are introduced themes from Beethoven, Schumann and Palestrina, in musical notation, as illustrations of melody, harmony and counterpoint, respectively. The authors in their preface give the opinion that "laboratory exercises, questions and problems given in a text-book are manifestly inadequate and unsatisfactory." This expresses quite a reaction from the popular tendency manifested some years ago, especially in the text-books by Gage and Avery. Many will sympathize with them in thinking that the laboratory guide book and the class text-book should be kept separate. Printed questions are often less valuable than those formulated for the occasion by an experienced teacher. It is not so obvious, however, that problems should be excluded; indeed there are probably few teachers of physics who would agree with the present authors on this point. In fact the first part of the book includes several dozen problems and experiments, a few of which are not very well selected. The general style, selection of material and mode of treatment are, however, good, and the book will probably be popular, particularly on account of the emphasis given to the relations of physics on all sides to human life and the interests of educated people.

The leading idea in Hoadley's text-book is to insure the coordination of reliability in the text, class demonstrations of stated laws, practical questions and problems on the application of these laws, and personal experimentation in the laboratory. The volume is a combination of text-book and laboratory manual intended to cover the work of a scholastic year in the high school. If it be admitted that two small separate volumes should be so combined—and every teacher has a perfect right to judge for himself about this—the work done by the author is exceedingly good. Considerable labor, it is true, will be required of the teacher who uses this book for the first time, and therefore has to secure the construction of the special apparatus for which the laboratory exercises are adjusted. But these exercises are well selected and well described. The practical questions and problems are numerous, and every page indicates that the author is methodical, careful and well informed regarding the needs and limitations of the class of students for whom he writes. He does not shun algebraic formulas or 'dodge' any real difficulties. Some formulas are given,

without deduction, as statements of physical laws. For elementary students this is often necessary, and the mathematical formulation is quite as desirable as verbal expression. Statements of fact are so generally accurate that the author can afford to be reminded of an error on page 188, where he has defined 'discord' more sharply than the facts warrant, by failure to recognize Mayer's law, which expresses the duration of the residual auditory sensation as a function of vibration frequency, the equation being expressible in a curve which Professor Mayer published in 1894 (*Am. Jour. Sci.*, Jan., 1894). In the chapter on electricity a very clear elementary discussion is given of such recent developments as the Wehnelt interrupter, self-regulating vacuum tubes, and wireless telegraphy. The book is abundantly worthy of commendation.

Snyder and Palmer's little volume on 'Problems in Physics' is a good collection intended for use in secondary schools, every problem having borne already the test of class use. For the convenience of overworked teachers it seems very desirable that a collection of answers should be published. Any competent teacher can work out all these problems for himself; but in the majority of cases it is only necessary that the pupil should work out such as have been assigned him. The teacher may assume the labor of verification wherever this may seem desirable, but he should not be subjected to unnecessary burdens.

Tory and Pitcher's 'Manual of Laboratory Physics' constitutes the course of elementary physics given in the laboratory of McGill University, Montreal. For each experiment there is a list of references, a list of apparatus, a short statement of the theory involved, practical directions, and a tabulated example. The arrangement is excellent, and the deductions of formulæ under the head of 'Theory of Experiment' constitute a good review of principles which the student is supposed to have mastered before entering the laboratory. Like all manuals of this kind, the book is a collection of the separate manuscripts prepared by the authors, while they were associated together as demonstrators in the physical laboratory of McGill University.

The manual by Schuster and Lees covers much the same ground as that of Tory and Pitcher, but the instructions given are more discursive and the book is not so well methodized. For somewhat advanced students, who are not so dependent as the beginner is apt to be on the oral guidance of an instructor, the book will be found very valuable. The authors have not aimed at completeness, 'being convinced that a student learns more by carefully working through a few selected and typical exercises, than by hurrying through a large number, which are often but slight modifications of each other.' They attach great importance to neat and accurate work, recorded in good form. The introductory chapter includes a satisfactory discussion of errors of observation.

The acceptability of a new book depends jointly on the author and the publisher. On opening it the reader expects to be able to consult any page without doing roughly by hand what the publisher ought to have done neatly by machinery. The manual just noticed is mechanically unsatisfactory, because the publishers have been guilty of the unreasonable slovenliness of issuing it with edges untrimmed. This fault is bad enough in the case of a magazine, where the insufficient excuse is to make allowance for future binding; but in the case of a book already bound it is inexcusable. American publishers have for the most part risen superior to such a senseless fad; but in England it seems still to hold sway. The present volume of 368 pages is most readily commended to any one who is willing to cut its leaves, to submit to the inconvenience of frayed edges, and to endure the untidiness of such edges after the book has been in use for some time in the laboratory.

W. LECONTE STEVENS.

Lehrbuch der vergleichenden Anatomie der wirbellosen Thiere. Von ARNOLD LANG. Zweite umgearbeitete Auflage. Zweite Lieferung. Protozoa, vollständig neu bearbeitet von Arnold Lang. Jena, G. Fischer, 1901. Mk. 10.

That this account of the Protozoa in the second edition of Lang's well-known 'Lehrbuch' is practically a new work is at once evident on

comparing the number of pages it contains with the number devoted to the Protozoa in the first edition of the same work. In the first edition 22 pages with 21 figures were given to this group; here we have 311 pages with 259 figures. The account of the Protozoa has thus been expanded until it occupies more space than was devoted in the first edition to the Protozoa, Porifera, Cnidaria, Plathelminthes and Vermes all together.

This increase in size gives opportunity for a most valuable résumé of the recent investigations among unicellular animals. Research has been exceedingly active among the Protozoa in the last decade, and a connected, well-digested summing up of the results of this and previous work, such as we have here, is most welcome. In the first edition of the 'Lehrbuch' all direct reference by name to the various investigators to whom the work was due was excluded from the text. In this edition Professor Lang wisely gives up this practice, so that the book serves likewise as a valuable introduction to the recent literature and history of the subject.

In plan of treatment there is much similarity to that of the first edition, though with some modifications. Most important of these is perhaps the preliminary monographic treatment (after the systematic outline) of three typical protozoa—a simple rhizopod, *Amœba* (pp. 35–47); a complicated radiolarian, *Cœlospathis ancorata* (pp. 47–55), and a ciliate infusorian, *Paramecium caudatum* (pp. 55–79). Besides an extended account of the structure, much attention is devoted here to the recent physiological work on these organisms, especially to their movements and reactions. The criticism may be made that the relation of the movements and method of reaction in the infusoria to the form and structure of the organisms is not brought out, although this appears to be the central point in the recent work on this subject.

In the remainder of the work the plan is followed of treating special topics throughout the entire group of Protozoa. Thus, we have chapters on the Protoplasm, the Pellicle, the Nucleus, the Centrosome, Protective Organs, Organs of Movement, Organs of Nutrition, Respiratory and Excretory Organs, Sense Organs, Reproduction, etc. The treatment is usually satisfactory, and is comparatively full. Thus, in the first edition the Organs of Nutrition are disposed of in a paragraph, while here twenty-five pages are devoted to the subject. Especially full and valuable is the account of the reproductive processes, which occupies nearly half of the text. Here the recent work of Schaudinn and others on the most varied members of the group is reviewed. The prominence of the Sporozoa is throughout noticeable, as compared with any previous general account of the Protozoa. Mention may be made of the especially full accounts of the reproduction and alternation of generations in *Trichosphærium* (Schaudinn), *Coccidium* (Schaudinn), the malaria parasite (pp. 229–239), and the Volvocidæ.

The text is clearly written, in an attractive style, and is well illustrated. Exception may perhaps be taken to the large figure of Paramæcium on page 56, which shows an unnatural shape, deformed by pressure, and is so coarsely drawn as to be misleading.

The book forms an essentially independent work on the Protozoa, and is furnished with extensive literature lists, a table of contents, a table indicating references in the text to organisms usually studied in laboratory courses, an alphabetical list of figures and a full index. It will be found valuable to every one interested in this fundamental group of animals.

H. S. Jennings.

Morphology of Spermatophytes. By John M. Coulter, Ph.D., Head of the Department of Botany in the University of Chicago, and Charles J. Chamberlain, Ph.D., Instructor in Botany in the University of Chicago. New York, D. Appleton and Company. 1901. Octavo. Pp. x + 188.

Methods in Plant Histology. By Charles J. Chamberlain, Ph.D., Instructor in the University of Chicago. Chicago, The University of Chicago Press. 1901. Octavo. Pp. viii + 160.

It speaks well for the intellectual activity of the corps of botanists in an American university that these two books, whose preparation must have involved a great deal of labor, have appeared within the past three or four

months. This is all the more notable when we observe that Dr. Chamberlain's name appears on both title pages.

In the 'Morphology of Spermatophytes' we have Part I. of what is evidently to be a work of considerably larger proportions, the present volume being fragmentary, dealing with the Gymnosperms only, and closing somewhat abruptly, even wanting an index. The preface was evidently written for the complete work, and this fact suggests the intention of the authors to bring out Part II. at no distant day. The part before us takes up stem, leaf, root, microsporangium, megasporangium, female gametophyte, male gametophyte, fertilization, and the embryo, for Cycadales, Ginkgoales, Coniferales, and Gnetales, devotes a few pages to fossil Gymnosperms (Cordaitales, Bennettitales, Cycadales, Ginkgoales, and Coniferales), and a few more to the phylogeny, and geographic distribution of the various orders mentioned above. The volume closes with a most useful bibliography of one hundred and ten titles. More than one hundred excellent illustrations (largely original, and often from photographs) add materially to the usefulness of the work.

This book must prove very helpful to the student who is working along morphological lines, and will tend to bring him back to strictly scientific work, in case he has been wandering through the fogs of so-called 'elementary ecology.' A valuable feature of the book is the citation and discussion of the different views held by botanists as to the morphology of particular structures. While the conclusions reached are not always those which we can approve, the treatment is such that the student is led to look on all sides of every problem before a decision is reached. We can not accept the authors' views as to the morphology of the structure supporting the ovules of *Ginkgo* (which we hold to be foliar instead of axial), nor that of the 'ovuliferous scale' of the Abietinæ (which we interpret as an enlargement and extension of ovular tissue; *i. e.*, it is ovular instead of axial or foliar in nature).

Dr. Chamberlain's book must prove useful in histological work in botanical laboratories in high schools and colleges. The plan of the work includes two parts, in the first of which are ten short chapters on apparatus, reagents, the making of mounts, killing and fixing agents, staining and the celloidin and glycerine methods. The author's success as an investigator and teacher is a guarantee of the value of the suggestions made in these chapters. The second part is mainly a series of selected examples of algæ, fungi, bryophytes, pteridophytes, and spermatophytes, in which the preceding suggestions are applied. This portion of the book is an admirable introduction to the vegetable kingdom, and must commend the volume to teachers and students. The book closes with a handy chapter of formulæ of reagents, and a good index.

These works are creditable to the university from which they appear, and deserve to be widely used.

CHARLES E. BESSEY.

SCIENTIFIC JOURNALS AND ARTICLES.

No. LIII. of the *Journal of American Folk-Lore* begins with a paper by Dr. J. W. Fewkes, in which he explains and interprets the Katcina worship of the Hopi or Moki of Arizona. The word is used to denote a masked personage, who, in a ceremonial dance, represents a divine being. Dr. Fewkes shows that these beings are spirits of clan ancestors, who are supposed to return from their dwelling in the underworld. Thus in mortuary prayers, the dying are addressed as about to become Katcinas, and are implored to send rain. Of the Katcinas, some are eponyms of Hopi clans; others are imported from abroad, or are imaginary creations. Chief of these spirits are the Sun Father and Earth Mother, parents of all clans. With sun worship also are connected some of the festivals; in the two great feasts of the Katcina clan are dramatized the arrival and departure of the Katcinas, who are supposed to leave the pueblo in July and return in February. They are said to go to the San Francisco mountains; but the underlying idea is that they enter the underworld through the gate of the Sun-house, the situation of which is indicated by a notch in these mountains, being the place of sunset at the time of the winter solstice. In the dramatic action held in the

sacred room or kiva, the Sun is personated by a man disguised as an eagle, whose performances symbolize the fertilization of the earth. In his most curious and interesting article, Dr. Fewkes makes it clear that the original significance of the ceremonies has long been forgotten by the Hopi. The editor, in treating of Kootenay medicine-men, makes clear the manner in which Christian ideas have intertwined themselves with Indian beliefs; he is of opinion that the Nootka god Kātse, whose name is kept secret, save that the dying chief communicates it to his grandchild, with instructions as to the manner of praying to this being, is none other than Jesus Christ. Miss A. C. Fletcher informs us that admonitions urging industry formed a part of Indian traditional teaching. Professor Rodney H. True discusses the relation of folk materia medica to modern knowledge. The 'Record of American Folk-Lore' is as full and instructive as usual. Altogether the new editor, Dr. A. F. Chamberlain, may congratulate himself on the presentation of a valuable number.

The American Naturalist for July opens with the second instalment of William M. Wheeler's paper on 'The Compound and Mixed Nests of American Ants,' this part being devoted to the known cases of social symbiosis among American species. Professor Wheeler gives Wasmann's table of the varied conditions under which symbiosis may occur, and then presents a scheme showing a more exact and natural grouping of the cases, to each of which an appropriate name is given. Under each of these headings the various species are treated in considerable detail; the article is of considerable length and much interest. R. W. Shufeldt presents a paper 'On the Osteology and Systematic Position of the Alcæ,' considering that the auks constitute a suborder standing between the gulls and petrels. A. W. Peters describes 'Some Methods for Use in the Study of the Infusoria' and 'Outram Bangs' gives some 'Notes on a Small Collection of Mammals from the Liu Kiu Islands' including the description of a new bat, *Hipposideros turpis*. C. W. Prentis describes in detail an interesting 'Case of Incomplete Duplication of Parts and Apparent Regulation in *Nereis virens* Sars.' The fourteenth instalment of the 'Synopsis of North American Invertebrates' contains the Hydromedusæ, Part III., by Charles W. Hargitt. Like the others of this valuable series, this comprises full keys to the families and genera, but it also has descriptions of the species. This number of the *Naturalist* contains the 'Quarterly Record of Gifts, Appointments, Retirements and Deaths.' The total amount of gifts reaches well into the millions, largely through the sums given by Andrew Carnegie to found libraries.

The Popular Science Monthly for August has as its frontispiece a portrait of Dr. Ira Remsen, the recently elected President of Johns Hopkins University. The first article, by J. J. Thomson, is 'On Bodies Smaller than Atoms.' Brother Potamian gives a sketch of 'Gilbert of Colchester,' the author of 'De Magnete,' showing his numerous discoveries in magnetism, and we have Part II. of 'The Peopling of the Philippines,' by Rud. Virchow. R. M. Wenley discusses 'Science and Philosophy,' noting the estrangement that seems to exist between the two and calling for harmony between them. The ninth part of 'A Study of British Genius,' by Havelock Ellis, is devoted to personal characteristics, and William James treats of 'Frederic Myers's Service to Psychology.' 'The Pose of the Body as Related to the Type of the Cranium and the Direction of the Visual Plane' is the subject of a paper by George T. Stevens, the writer considering that many benefits and ills depend upon the direction of the visual axis, and that when these are so directed as to be injurious they can be rectified. The final article on 'The Great Mortality,' by Edward P. Cheyney, is a description of the 'Black Death,' now known as the bubonic plague, which devastated Europe in the fourteenth century.

Bird Lore for July–August, opens with 'First Impressions of Hawaiian Birds,' by H. W. Henshaw, an article which rather impresses the reader with the comparative scarcity of bird life and the difficulties in observing it. Frank M. Chapman contributes 'A Nighthawk Incident,' with some excellent illustrations, after photographs of the bird, and Verdi Burtch de-

scribes 'The Birds of a Marsh' near Keuka Lake, N. Y. The fifth series of 'Birds and Seasons' is devoted to the birds to be seen and studied in August and September, as noted by contributors from Boston to Stockton, Cal., with suggestions for the season's study and reading.

THE first number of *The Museums' Journal* of Great Britain is issued promptly, and naturally commences with a statement of the objects of the Museums' Association and its journal. The address of the President, Sir William Turner, delivered at the Edinburgh meeting of the Association follows, and this is devoted to the history of 'The Public Museums of Edinburgh.' A sample is submitted of 'A Museum Label,' descriptive of British pottery and as criticism is invited it may be said that it will strike some as rather long, although it is undeniably replete with information. 'Museum Notes,' 'At Home and Abroad,' complete the number.

IN the issue of SCIENCE for April 26, 1901, there was given a somewhat detailed account of a proposed journal for the statistical study of biological problems, suggested by Professor Karl Pearson and Professor E. F. R. Weldon. We are glad to learn that the first number of the journal, which is called *Biometrika*, will be published in October. Professor C. B. Davenport, of the University of Chicago, is one of the editors, the others being Professors Pearson and Weldon. The journal will be published by the Cambridge University Press and will appear about four times a year. The following papers are ready or in preparation:

'Biometry': FRANCIS GALTON.

'On the Terminology and Notation of Biometric Investigations.'

'Variationsstatistische Probleme und Materialien': Professor Dr. F. LUDWIG.

'Criminal Anthropometry and the Identification of Criminals': Dr. W. R. MACDONELL.

'Critical Bibliography of Statistical Memoirs. I. Heredity': Professor W. F. R. WELDON.

'Anthropometric Data from Australia': W. POWYS.

'Variations in *Synapta inhærens*': Professor C. L. EDWARDS.

'Homotyposis in the Egg of the House-Sparrow': Dr. A. LEE and Professor K. PEARSON.

'The Cuckoo's Egg': OSWALD LATTER.

'Variation in *Aurelia*': E. T. BROWNE.

'Inheritance of the Duration of Life and the Intensity of Natural Selection in Man': Miss M. BEETON and Professor K. PEARSON.

'Artificial Selection, being a Comparison of the Distributions of Conscripts and Recruits in various Italian Provinces': Professor W. F. R. WELDON.

'Results of Cooperative Investigation on the Laws of Inheritance in Plants. I. The Shirley Poppy.'

'Variation and Correlation of the parts of the Human Skull. A Quantitative Study of the Naqada Crania': Miss C. D. FAWCETT.

'Extended and Improved Tables of Probability Integrals': W. F. SHEPPARD.

'Variation in the Form of the Helix of the Shell in *Clausilia laminata* (Montagu)': Professor W. F. R. WELDON.

'Mathematical Contributions to the Theory of Evolution. XI. The Influence of Natural Selection on the Variability and Correlation of Characters': Professor K. PEARSON.

'On a Physico-statistical Theory of Heredity': G. U. YULE.

'A Statistical Study of the Wild Bee': Professor F. Y. EDGEWORTH.

AN Index to the *Experiment Station Record*, covering the first twelve volumes, and containing more than one hundred thousand entries, has been prepared and will probably be published in the autumn.

THE Senate of the University of London has decided to publish periodically an official organ, to be called *The London University Gazette*, which will contain class lists, new regulations, dates of examinations, etc. The paper will appear about twenty times in the first year, beginning in October.

DISCUSSION AND CORRESPONDENCE.

THE VISUAL PERCEPTION OF SPACE.

THE fact to which Professor Thorndike called attention in the last number of SCIENCE must appear extraordinary to those who have not

considered the senses from the point of view of psychology. The ordinary man tends to regard our perceptions as copies or models of an outside world. The sense organs intervene, of course, and knowing that in vision the rays of light form an image on the retina, one is likely to think of the mind as viewing this picture from behind. As Professor Thorndike remarks, if one walks toward a chair, the apparent size of the object does not alter—at least not greatly or obviously—although the image on the retina becomes smaller. As I lecture to my class, the retinal images of the heads of the students on the back seats may be only one-tenth the size of those in front, yet they look only slightly smaller. But this is by no means the only disparity between the image on the retina and my perception. To begin with, the image is upside down and there are two images. Then the corners of my desk look like right angles, although they are by no means such in the pictures. I know by experiment that I can at one time have a distinct image of only one of the nearer heads, yet in my perception all the heads are distinct. A photograph in which very near and comparatively distant objects are included will in its distortion of perspective and blurring give some idea of what the image on the retina is like and how different it is from the perception.

Some of these facts were known to Berkeley, who in his 'New Theory of Vision,' first published in 1709, argues that visible objects are a system of arbitrary signs. In regard to apparent magnitude he writes:

> When we look at an object, the tangible figure and extension thereof are principally attended to; whilst there is small heed taken of the visible figure and magnitude, which, though more immediately perceived, do less sensibly affect us, and are not fitted to produce any alteration in our bodies.
>
> 60. That the matter of fact is true will be evident to any one who considers that a man placed at ten foot distance is thought as great as if he were placed at a distance only of five foot; which is true, not with relation to the visible, but tangible greatness of the object: the visible magnitude being far greater at one station than it is at the other.

Professor James, as always, discusses the matter admirably. He says ('Principles of Psychology,' II., 179):

> When the object by moving changes its relations to the eye the sensation excited by its image even on the same retinal region becomes so fluctuating that we end by ascribing no absolute import whatever to the retinal space-feeling which at any moment we may receive. So complete does this overlooking of retinal magnitude become that it is next to impossible to compare the visual magnitudes of objects at different distances without making the experiment of superposition. * * * As I look along the dining-table I overlook the fact that the farther plates and glasses *feel* so much smaller than my own, for I *know* that they are all equal in size; and the feeling of them, which is a present sensation, is eclipsed in the glare of the knowledge, which is a merely imagined one.

Professor Newcomb recently called my attention to the paradox that while we are

Fig. 1. The man and boy are of the same size.

said to judge the distance of objects of known size by the angles they subtend, our

perception of distance is more accurate than our perception of the visual angle. Owing to the fact that we must commonly ignore the visual angle in order to get useful perceptions, our interest in it is small and our knowledge vague. The moon, for example, always subtending the same angle, looks much larger at the horizon than at the zenith. If the reader is asked whether the little finger if held before the moon will cover it, he will probably say 'No,' or else hesitate to answer. As a matter of fact, the little finger covers the moon, and when it is removed we have a further illustration of the subject in the fact that the moon appears decidedly reduced in size, owing doubtless to a vague comparison with the finger.

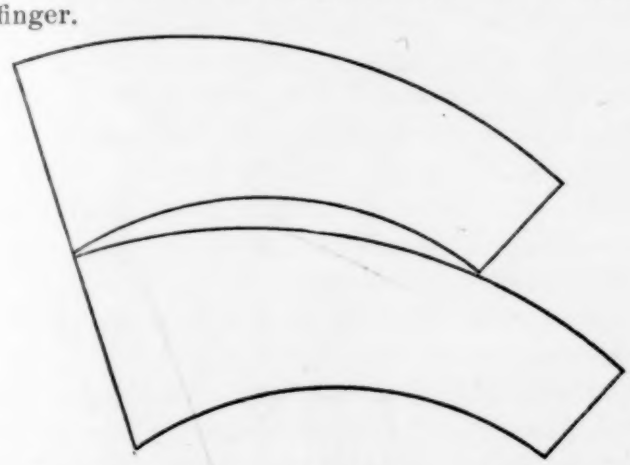

FIG. 2. The upper and lower areas are of the same size and shape.

I have made a few experiments on the accuracy with which the retinal area or visual angle can be judged under different conditions, and on the relation between the geometrical magnitude and the perception, and hope to continue them, though it is difficult to obtain quantitative results. The phenomena can be studied to advantage with the aid of mirrors, and it appears that data of interest can be secured by a consideration of photographs and of paintings and drawings. This I may illustrate by reproducing a figure from Professor Münsterburg's 'Pseudoptics,' in which the figures of the man and boy are of the same objective size.

While our ability to compare the retinal magnitude of objects at different distances and in different directions is very defective, the perception of visual magnitude when objects are side by side is perhaps the most accurate of all the senses, a difference of one-hundredth being noticeable. Yet even in this case the retinal area yields readily to suggestion as is shown by the accompanying figure, in which the two areas are of exactly the same size.

In a recent paper,* I have described what seems to me one of the most striking disparities between our perceptions and the physical world —no less than the perception of order in time as extension in space. If, for example, first a green and then a red surface pass rapidly behind a narrow slit, one does not see green followed by red, but simultaneously a surface with green below, white in the middle and red fading into black above. Physiologically we have a retinal process, consisting of a certain commotion caused by green light, lasting say 1/20 sec., then a mingling of this process with that excited by red, then that excited by red gradually subsiding. But this time series is perceived as a spatial continuum, and the field is, perhaps, three times as large as the window through which it is seen. If three squares, as shown on the left of the figure, are seen as they pass the window WW', they do not appear one after the other, but are seen simultaneously as indicated to the right.

This conversion of a time into a space order is also what always happens in ordinary vision. If the eye moves so that the line of sight moves

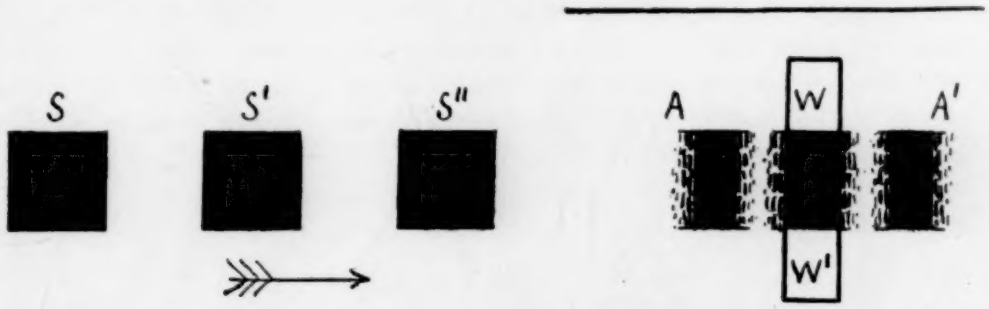

FIG. 3. The squares at the left appear as shown at the right when seen as they pass the window (WW') of the size indicated.

* 'On the Relation of Time and Space in Vision,' *The Psychological Review*, **7**: 325–343, 1900.

over a row of fifty books, each retinal element is excited in succession by each book, but we do not see one book taking the place of the other, but all the books side by side. Further, when the eye sweeps over fifty books in 1/10 sec., each book is seen, or appears to be seen, with perfect distinctness, though if the books moved at the same rate over the eye they would completely fuse together. Our perceptions in no wise correspond to the physiological processes in the eye, but are what they should be for our safety and convenience.

J. McKeen Cattell.

Columbia University.

CIRCULAR OF INFORMATION IN REGARD TO THE CAUSATION AND PREVENTION OF MALARIAL FEVER.

Recent investigations have shown that malarial fever belongs to that class of diseases which require for their transmission the active intervention of a definite kind of mosquito, *i. e.*, *Anopheles*. This genus is not the common one of this region, but is nevertheless present in many localities.

The organism causing malarial fever (*Plasmodium malariæ*) is probably a true parasite, and, so far as we know at present, finds the conditions necessary for its existence only in the living human body and in this genus of mosquito, the latter becoming infected by sucking the blood from an infected human being. The malarial organism having thus entered the stomach of the mosquito, passes through certain changes in the body of the infected insect, and at the end of about ten days reaches the poison gland. After this time, if the mosquito bites another human being, the malarial organism is introduced into the circulation of the latter and malarial fever follows.

So far as we know certain localities are 'malarious' only because they furnish favorable conditions for breeding this mosquito. Malarial fever would not occur in any malarious district, unless some infected human being were in it, or came into it and infected the mosquitoes, which in turn infected other human beings.

Recent observations in the intensely malarial districts in Italy and Africa have shown that even newcomers in these regions who purposely expose themselves by living in the most highly malarious area, for example the Roman Campagna, do not develop malarial fever, if they are carefully protected from the bites of mosquitoes; and further, it has been shown that this disease may be produced with certainty in any locality if a mosquito of the genus *Anopheles* is allowed to bite a person suffering from malarial fever and then, after a sufficient time, is allowed to bite a healthy person.

Certain simple precautions suffice to protect persons living in malarial districts from infection:

First.—Proper screening of the house to prevent the entrance of the mosquitoes (after careful search for and destruction of all those already present in the house), and screening of the bed at night. The chief danger of infection is at night, inasmuch as the *Anopheles* bite mostly at this time.

Second.—The confinement and continuous screening of persons in malarial districts who are suffering from malarial fever, so that mosquitoes may not bite them and thus become infected.

Third.—The administration of quinine in full doses to malarial patients to destroy the malarial organisms in the blood, and persistence in the use of the remedy even for a few weeks after apparent recovery.

Fourth.—The removal of the breeding places of the mosquitoes through drainage, filling up of holes and surface pools, and emptying of tubs, pails, etc., which contain stagnant water. These mosquitoes particularly breed in surface rain pools and surface stagnant water, where there are no fish; also exceptionally in pails, tubs, barrels and tanks of standing water, though they seem mostly to prefer natural accumulations.

Fifth.—In pools which cannot be drained or filled, the destruction of the mosquito larvæ by the use of petroleum thrown upon the surface, by the introduction of minnows and other small fish which eat the larvæ, or by both methods.

These measures, if properly carried out, will suffice greatly to restrict and largely to prevent the occurrence of new malarial infections.

It is the desire of the Department of Health to obtain information as to the location of the cases of malarial fever, so that the people may be instructed as to the danger of infection and the methods of avoiding it.

It must be remembered that when a person is once infected, the organism may remain in the body for many years, producing from time to time relapses of the fever. A case of malarial infection in a house, whether the person is actively ill or the infection is latent, in a locality where the *Anopheles* mosquitoes are present, is a constant source of danger, not only to the inmates of the house, but to the immediate neighborhood, if proper precautions are not taken.

Malarial fever is quite prevalent in certain boroughs of New York City. It is likely to extend to the boroughs of Manhattan and Brooklyn in view of the extensive excavations and consequent formation of rain-pools in various parts of these boroughs, if means are not employed for its prevention.

The Board of Health desires the cooperation of all physicians in its efforts to disseminate information in regard to the causation and prevention of malarial fever, and in its efforts to restrict the prevalence of this disease in New York City.

HERMANN M. BIGGS.

THE BRITISH CONGRESS ON TUBERCULOSIS.

THE Congress which met at London at the end of last month appears to have been remarkably successful. There were over 2,500 members, including the following delegates:

United States: Professors Osler and Janeway.
Austria: Professors von Schroetter and Davorak.
Belgium: M. le Sénateur Montefiore Lévi and Van Ryn.
Bulgaria: Mikailovsky.
Denmark: Professor Bang and Dr. Charles Gram.
France: Professors Brouardel, Bouchard and Nocard.
Germany: Professors Gerhardt, Flügge, Von Leyden, Frankel, Koch, Werner, Dettweiler, Dr. Freund.
Holland: Professor Thomassen.
Hungary: Professor Koranyi.
Norway: Dr. Malm.
Portugal: Professor da Silva Amado.
Roumania: Dr. Cantacuzino was unavoidably absent.
Spain: Señor Don Antonio Espino y Capo.
Sweden: Hof Marshal Printzjold.
Switzerland: Dr. Neuman.

The Congress met in four sections: State and municipal, medical, pathology and veterinary, and there were besides a number of general meetings. The addresses of Professors Koch and Brouardel attracted special attention, more especially Professor Koch's claim that the bovine tubercle could not develop in the human body. No one present seems to have known of Professor Theobald Smith's careful research, showing that bovine and human tubercle bacilli are not identical. At the close of the Congress, the following resolutions were adopted:

That tuberculous sputum is the main agent for the conveyance of the virus of tuberculosis from man to man and that indiscriminate spitting should therefore be suppressed.

That it is the opinion of this Congress that all public hospitals and dispensaries should present every out-patient suffering from phthisis with a leaflet containing instructions with regard to the prevention of consumption and should supply and insist on the proper use of a pocket spittoon.

That the voluntary notification of cases of phthisis attended with tuberculous expectoration and the increased preventive action which it has rendered practicable has been attended by a promising measure of success and that the extension of notification should be encouraged in all districts in which efficient sanitary administration renders it possible to adopt the consequential measures.

That the provision of sanatoria is an indispensable part of the measures necessary for the diminution of tuberculosis.

That in the opinion of this Congress and in the light of the work that has been presented at its sittings medical officers of health should continue to use all the powers at their disposal and relax no effort to prevent the spread of tuberculosis by milk and meat.

That in view of the doubts thrown on the identity of human and bovine tuberculosis it is expedient that the Government be approached and requested to institute an immediate inquiry into this question, which is of vital importance to the public health and of great consequence to the agricultural industry.

That the educational work of the great national societies for the prevention of tuberculosis is deserving of every encouragement and support. It is through their agency that a rational public opinion

may be formed, the duties of public health officers made easier of performance and such local and State legislation as may be requisite called into existence.

That this Congress is of opinion that a permanent national committee should be appointed (*a*) to collect evidence and report on the measures that have been adopted for the prevention of tuberculosis in different countries; (*b*) to publish a popular statement of these measures; (*c*) to keep and publish periodically a record of scientific research in relation to tuberculosis; and (*d*) to consider and recommend measures of prevention. This Congress is further of opinion that such a committee should consist of representatives to be elected by the great national societies formed for the suppression of tuberculosis and also representatives nominated by the various governments. It is further of opinion that all international committees and great national societies whose object is the prevention of tuberculosis should be invited to cooperate.

That, in the opinion of this Congress, overcrowding, defective ventilation, damp, and general unsanitary conditions in the houses of the working classes diminish the chance of curing consumption and aid in predisposing to and spreading the disease.

That while recognizing the great importance of sanatoria in combating tuberculosis in every country the attention of governments should be directed towards informing charitable and philanthropic individuals and societies of the necessity for anti-tuberculous dispensaries as the best means of checking tuberculous disease amongst the industrial and indigent classes.

That the following question be submitted to the consideration of the next Congress: The constitutional conditions of the individual which predispose to tuberculosis and the means whereby they can be modified.

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*GEOLOGICAL EXPLORATIONS AT PIKERMI.**

THE geological excavations which the Trustees of the British Museum have (by the kind permission of Mr. Skousés, the owner of the ground) been carrying on at the Pliocene deposits of Pikermi, near Athens, since the early spring, have now been brought to a conclusion for the season. Judging from the preliminary reports which have been received from Dr. A. Smith Woodward, who was sent out by the Museum to superintend the excavations, the results from a scientific and pecuniary point of view have well justified the trustees in their decision to undertake this important piece of geological research. We believe that the initiative in the matter is due to Sir Edwin Egerton, H. M. Minister at Athens, who was also mainly instrumental in obtaining the necessary permit to excavate from Mr. Skousés, formerly Greek Minister for Foreign Affairs. The willing cooperation of the University of Athens in the person of Professor Skuphos, the accomplished paleontologist of the University Museum, was easily secured, and his help and advice have been invaluable throughout the whole period of the work. The most cordial relations have existed between Professor Skuphos and Dr. A. S. Woodward, and the division of the specimens which have been discovered has, it is understood, been amicably arranged by the British Museum and the University of Athens. It is said to be extremely doubtful whether there is any Greek law assimilating fossils to works of art; but, however that may be, we are happy in knowing that both the institutions concerned are satisfied with the agreement which has been arrived at as regards the portion of the collections which each is to retain.

Pikermi, where the fossils are found, is near the Marathon road, about 12 miles from Athens; and the specimens are usually found at a considerable depth below the bed of a mountain torrent. This is, of course, not the first time that excavations have been made in these deposits. In the early fifties Professor Albert Gaudry, the eminent French geologist, conducted some explorations which resulted in a great find of Tertiary mammalia, identical with those of Léberon, Samos and Maragah. Most of the specimens obtained by Gaudry are in the Paris Museum. Later, the Vienna Academy made a collection on a smaller scale from the same place; and about 1885 the Duke of Orleans was allowed to dig there, but he remained only a short time and found nothing of importance. Before the present occasion no Englishman had made any geological research at Pikermi, and the British Museum contained no collection from these beds. This deficiency in our great national storehouse has now been made good in a splendid manner, as may be judged from the fact that 47 large cases containing the Museum's share of the fossils found are at the present moment on their way to England.

* From the London *Times*.

Among the principal finds recorded may be mentioned remains of a huge proboscidean, including two femurs each over a meter in length, a fine series of excellently preserved skulls and other bones of rhinoceros; *Mesopithecus*, an old-world monkey, remains of which are rarely met with in any part of the globe as fossils; several almost complete skulls of *Mastodon;* skulls, teeth, and bones of *Machærodus*, the great saber-toothed tiger, remarkable for the great development of the canine teeth, and also for its wide geographical distribution. Remains of this animal have been met with in England in Kent's Cavern, Torquay, in Creswell Crag Caves, Derbyshire, and in the Norfolk forest-bed. Dr. Woodward also reports the discovery of innumerable bones of *Hipparion*, the three-toed and most immediate predecessor of the horse of the present day, hyæna and other carnivores, antelopes, giraffe with limb-bones very long and slender; *Helladotherium*, a short-necked giraffe allied to the *Okapi*, the new ruminant mammal recently brought home by Sir Harry Johnston from the Semliki forest in the Congo State; and *Samotherium*, a large ruminant, first discovered, it is believed, by Dr. Forsyth Major in the lower Pliocene beds of the Island of Samos, off Asia Minor, and said to connect *Helladotherium* and the giraffe with some of the ancient aberrant antelopes of Pikermi. Traces of *Chalonians* were abundant and include, as one of the prizes of the explorations, remains of perhaps the largest tortoise ever found in Europe. Very few bones of rodents were met with, and birds do not seem to have been numerous; but a considerable collection of land shells was obtained. It is curious that no traces of plant life were observed.

The bones occur on definite horizons in immense numbers, and the marly material is quite soft until it is dried, when it hardens. In places the remains are so jammed together that it is difficult to extract or to separate them. The carcases appear to have been buried entire, with the flesh and integument, in vast numbers, probably by torrential action, a great number having had their limbs sharply broken, evidently at the time of death. It is worthy of note that the extinct animals found in this late Tertiary deposit at Pikermi mostly relate to the present African fauna.

Dr. A. S. Woodward, it will be seen, has carried out the official mission entrusted to him in a most creditable manner. By his exertions and careful superintendence the national collection of paleontology at South Kensington will be immensely enriched. Before returning home Dr. Woodward, at the request of Sir Edwin Egerton, has arranged to inspect another ossiferous deposit on the island of Eubœa.

SCIENTIFIC NOTES AND NEWS.

THE permanent secretary of the American Association, Dr. L. O. Howard, asks us to state that those who have responded to his invitation to send in their names and dates for special Association Pullman accommodation are so divided in their choice of route that it will be impossible for him to arrange to bring parties together on the journey in the way proposed. The Pennsylvania limited, which leaves New York at 9:55 A. M. and Philadelphia at 12:20 P. M., reaching Chicago at 8:55 A. M., was not included in the time-tables published recently in this journal. Neither were there given time-tables of the trains on the New York Central road, though for those living in New York and New England this is probably the most convenient route, as it is cooler than those further to the south. We may take occasion to call attention to the excursion to the Grand Canyon of Arizona arranged to follow the meeting, of which an advertisement will be found in this issue of SCIENCE. We are also requested to state that the meeting of the Council will be held at 3 o'clock on Saturday, August 24, instead of at 12.

THE seventy-third meeting of German Men of Science and Physicians will, as we have already stated, be held at Hamburg, from the twenty-second to the twenty-eighth of September. Professor R. Hertwig, of Munich, is president of the meeting, while Professor van't Hoff is president of the scientific sections and Professor Naunyn of the medical sections. There are in all twenty-seven sections for the medical sciences and eleven in the natural and exact sciences. The latter sections correspond in general with

those of our own Association, except that there are sections for applied chemistry, for geophysics and for geography, while there is none for social and economic science. Among the special lectures promised are the following: Dr. E. Lecher on 'Hertzian Waves,' Professor T. Boveri on 'Fertilization,' and Professor W. Nernst on 'Electro-chemistry.'

Prince Henri d'Orléans, who has made important geographical discoveries in Asia and Africa, died at Saigon, China, on August 9, aged thirty-three years.

We also regret to record the death of Professor August Tenne, curator of the mineralogical collections of the University of Berlin; of M. David Dickson, director of the practical School of Agriculture, at Berthonval, France, and of Mr. Carsten Holthouse, at one time lecturer on anatomy at the Aldersgate School of Medicine and the senior fellow of the Royal College of Surgeons, who was in his ninety-first year.

The steamship *Discovery* of the British Antarctic Expedition, sailed from Cowes on August 6, and the *Gauss*, of the German Expedition, sailed from Kiel on August 11. The *Discovery* should reach the Cape about September 12 and Melbourne about a month later. It will proceed thence to Littleton, New Zealand, which place it will leave about the middle of December and will probably come in contact with the ice pack about the first of January.

Mr. Willis L. Moore, chief of the Weather Bureau, will leave Washington early in September for the Yellowstone National Park to make an inspection of that region with a view to the establishment of a meteorological observatory.

Professor Lucien M. Underwood, of Columbia University, and Mr. O. F. Cook, special agent for tropical agriculture for the Department of Agriculture, have returned from a botanical expedition to Porto Rico.

Dr. Peter A. Joder has been appointed assistant chemist at the Utah Agricultural College and Station, and Mr. W. T. Shaw has been appointed assistant entomologist at the Iowa Station.

Professor H. C. Wilson, according to a telegram to the Harvard College Observatory, observed Encke's comet on August 5.

Mr. A. L. Rotch, director of the Blue Hill Observatory and the American member of the International Aeronautical Committee, made a balloon ascension from Strasburg, Germany, with his colleague, Professor Hergesell, on July 4, in connection with the eighteenth series in Europe. They reached a height of about 14,000 feet. The meteorological observations will be published in the United States *Monthly Weather Review*.

It is reported in *Nature* that the French Minister of War has asked the Paris Academy of Sciences to give an opinion as to the possibility of danger arising from the establishment of wireless telegraphy stations in the neighborhood of magazines containing powder or other explosives. It is suggested that the nature of the cases containing the explosive may be an important matter for consideration in connection with the subject.

The British Institution of Mechanical Engineers held its summer meeting at Barrow-in-Furness, under the presidency of Mr. W. H. Maw, beginning on July 30.

Mr. James Angus, of West Farms, N. Y., who has given a valuable collection of butterflies to the American Museum of Natural History, and more recently a collection of Indian implements to the Providence Museum, has given to the latter institution his collection of corals and agates.

Mr. J. Ewing Mears, of Philadelphia, has presented the George W. Mears Memorial Medical Library of Indianapolis with 4,000 medical books. The library was established as a memorial to his father, who practised medicine in Indianapolis.

Andrew Carnegie has offered Montreal $150,000 for a library, provided the city will contribute a site and spend $15,000 yearly in maintenance.

The secretary of the Marine Biological Association of the West of Scotland, Mr. John A. Todd, 190 West George St., Glasgow, has sent a notice stating that the General Committee of

the Association offers the following prizes, to be called the *Fred. P. Pullar Memorial Prizes*, provided by Sir John Murray, the honorary president of the Association, in memory of the late Fred P. Pullar, who was associated with him in the Bathymetrical Survey of the Scottish Fresh Water Lochs, who took much interest in the Millport Marine Station, and who lost his life in the unfortunate ice accident on Airthrey Loch, Bridge of Allan, on the 15th of February, 1901.

1. A prize of £50 for a paper on 'The Seasonable Distribution and Development in the Pelagic Algæ in the Waters of the Clyde Sea Area.'

2. A prize of £50 for a paper on 'The Reproduction, Development and Distribution of the Clyde Sea Area of the Genera *Nyctiphanes* and *Boreophausia*.'

3. A prize of £50 for a paper on 'The Formation and Distribution of Glauconite in the deposits of the Clyde Sea Area and the adjacent seas of Scotland.'

These prizes are open to investigators from any part of the world who conduct observations in the several subjects at the Millport Marine Station, and who produce, at any time before January 1, 1905, papers which, in the opinion of a committee of three scientific men, to be nominated by the committee of the Association and by Sir John Murray, shall be deemed of sufficient value to merit publication. Those proposing to work for any one of these prizes should make known their intention to the secretary of the Association in order that the necessary arrangements may be made.

AT the last session of Congress the medical corps of the Army was increased from 192 to 321, and examinations for appointments as assistant surgeons in the U. S. Army will be resumed in Washington on September 2. The salary is $1,600 per year, gradually increasing until after twenty years it amounts to $2,500 and may be more if promotion to the position of lieutenant-colonel follows. The medical officers of the Army are also allowed free quarters, traveling expenses, instruments, books, etc. Candidates must have had a year's hospital experience or two years of private practice and must not be more than twenty-nine years of age. Details in regard to the examination can be obtained from the Surgeon-General's office, Washington.

THE United States Civil Service Commission announces that the examination which was announced to he held on September 3 for the position of computer in the Coast and Geodetic Survey has been cancelled, for the reason that the position for which the examination was to have been held has been filled by the transfer of a person already in the classified service.

THE organizing committee of the fourteenth International Medical Congress, which meets at Madrid next April, held a meeting on June 11, at which plans were discussed and promises of support given on behalf of the government and the municipality. The work of the Congress is to be divided into sixteen sections, as follows: (1) Anatomy (anthropology, comparative anatomy, embryology, descriptive anatomy, normal histology and feratology); (2) physiology, biological physics and chemistry; (3) general pathology, pathological anatomy and bacteriology; (4) therapeutics, pharmacology, and materia medica; (5) internal pathology; (6) neuropathology, mental diseases and criminal anthropology; (7) pædiatry; (8) dermatology and syphilography; (9) surgery and surgical operations; (10) ophthalmology; (11) otology, rhinology and laryngology; (12) odontology; (13) obstetrics and gynæcology; (14) military and naval medicine and hygiene; (15) epidemiology and technical sanitary science; (16) forensic medicine.

THE foreign trade of the United States during the fiscal year ended June 30 aggregated in value $2,310,413,077, being an increase of $65,988,811 compared with that of the previous year. Of this total the exports comprised $1,487,656,544, exceeding those of the previous year by $97,173,462, and the imports aggregated $822,756,533, being $27,184,651 less than those for the fiscal year 1900. The balance of trade in favor of the United States for that period reached a total of $664,900,011, being an increase of $120,359,113 over the balance for the previous year. Under the new relations with Hawaii and Porto Rico the commerce with those islands is no longer included in the regular statement of the foreign commerce of the United States. Had they been so included, as has been the case in former years, the total exports would have exceeded $1,500,000,000,

as the exports to those islands during the year have aggregated about $25,000,000.

The St. Petersburg *Novoe Vremya*, as reported by Reuter's Agency, learns from Yeniseisk that Lieutenant Kolomütseff, in command of the steamer *Zaria*, which has on board the members of the Russian Polar expedition, under Baron Toll, has just arrived at that place to re-coal. Lieutenant Kolomütseff reports that the *Zaria* wintered in the Bay of Taimyr in 76° 8′ north latitude, and 95° 6′ east longitude, and that the winter passed fairly well except for some cases of scurvy among the crew. Lieutenant Kolomütseff twice endeavored to reach Kamchatka by land, but without success. He started on his first attempt on February 2, but was obliged to return at the end of 18 days, owing to lack of food for his dogs. His second fruitless attempt cost him 26 days, in the course of which he was able to explore the whole of the coast of Taimyr Bay. On April 18 he again left the *Zaria*, and arrived at Goldchik after a march of 40 days, during which he lived on the flesh of bears and reindeer. From Goldchik he proceeded with reindeer to Doudinki, and from there by boat to Yeniseisk. His present object is to establish coaling stations for the *Zaria* in Dickson Bay and on the islands of New Siberia.

Professor W. A. Herdman, as *Nature* learns, has received letters and natural history notes from Mr. Nelson Annandale and Mr. H. Robinson, who left Liverpool University College a short time ago for a year's exploration in the Siamese Malay States. Some of the observations made and material collected will be described at the forthcoming meeting of the British Association at Glasgow. Meanwhile, it is interesting to read the following notes from the naturalists: "We have obtained what is either a second species of *Periophthalmus* or a genus closely allied to it, and we have to-day ourselves collected a series of young specimens, which show that in extreme youth the eyes are normally placed on the sides of the head, and only migrate to the top later in life. We also got in water less than a fathom a most interesting case of commensalism, in which a small crab, with a very soft back, has the two last pairs of legs specially modified for holding on a sea-anemone, which it grasps by the foot. * * * A good many cases of mimicry between different orders and families, principally between spiders and ants, homoptera and beetles, were noted—in at least ten cases the mimicked animal being an ant.

UNIVERSITY AND EDUCATIONAL NEWS.

Mrs. Caroline Stannard Tilton, of New Orleans, has given $50,000 for a Tilton memorial library at Tulane University.

By the will of the late Herbert B. Adams, professor of history in the Johns Hopkins University, that University is made the residuary legatee. Amherst College is given $2,000 for the library and the American Historical Association is given $5,000.

We are requested to state that in spite of the damage the building of the College of Physicians and Surgeons, Chicago, the medical school of the University of Illinois, suffered recently from fire, the administration of the College has suffered no serious disturbance and the institution will in the autumn be housed and equipped better than ever before.

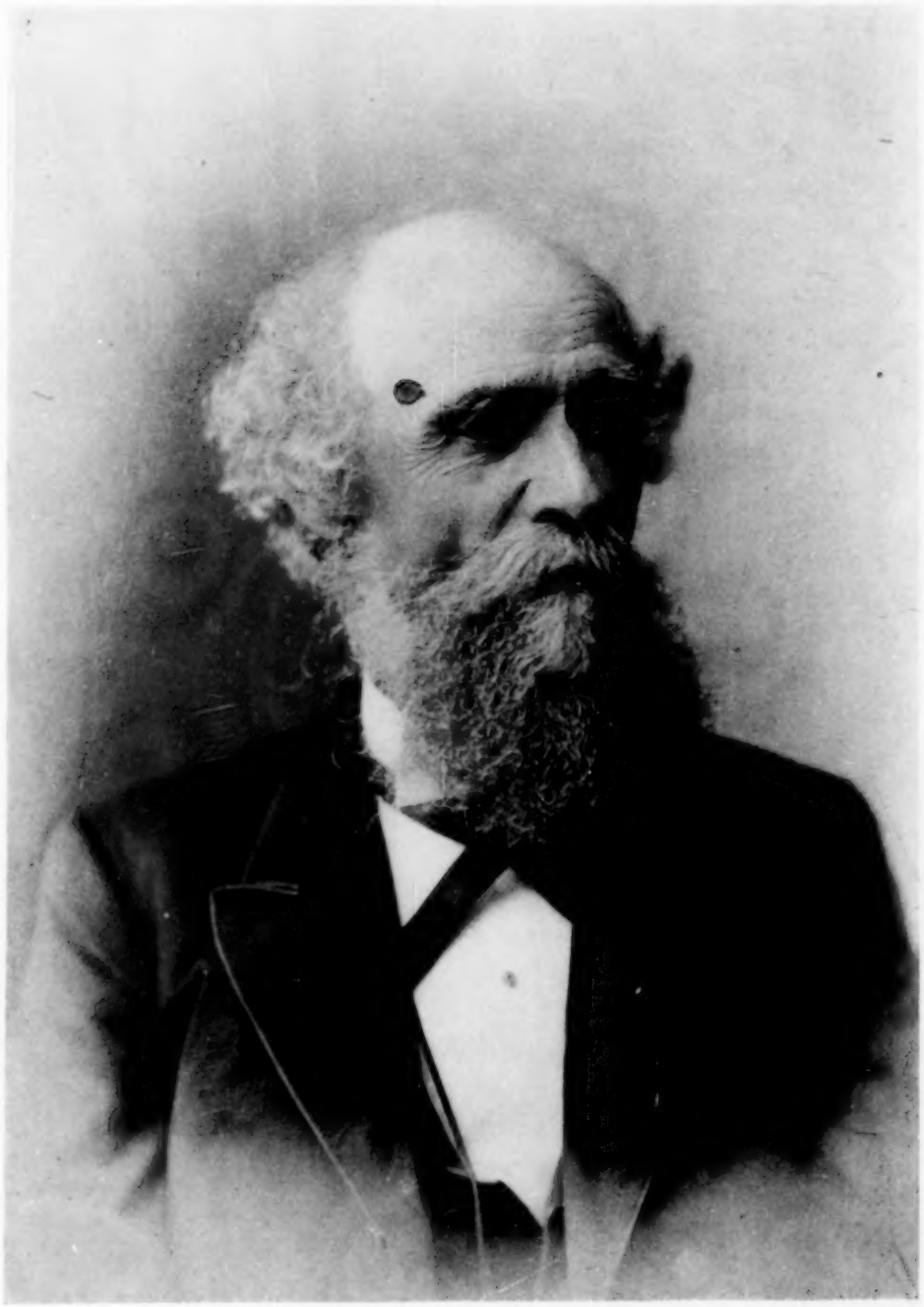
Dr. Charles Burton Thwing, professor of physics in Knox College, has been called to the same chair in Syracuse University.

Professor W. S. McCormack, of University College, Dundee, has been appointed secretary of the endowment for the Scottish universities, established by Mr. Carnegie.

The Council of University College, London, has appointed Mr. J. D. Cormack, B.Sc., of Glasgow, to the chair of mechanical engineering vacant by the resignation of Professor Hudson Beare on his appointment as regius professor at Edinburgh, and Mr. Edgar Walford Marchant, D.Sc., to the lectureship in electrotechnics vacated by Mr. Alfred Hay's appointment to a professorship at Coopers Hill.

Dr. R. T. Hewlett, of the Jenner Institute of Preventive Medicine, has been appointed professor of general pathology and bacteriology at King's College, London.

Mr. R. C. Porter, now lecturer in engineering at the government school at Cairo, has been appointed lecturer of mechanical engineering at Birmingham University.



Very truly yours
Jerome LaCanta